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Lycophytes, Monilophytes, and Gymnosperms of the Delmarva Peninsula, an Annotated Checklist

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ABSTRACT.—Distinctive and usually well known components of the flora of most regions include the spore-bearing vascular plants [lycophytes (clubmosses, spike-mosses, and quillworts) and monilophytes (true ferns)], and the non-flowering seed plants [gymnosperms (hemlock, pine, cypress, cedar)]. The Delmarva Peninsula of the Atlantic Coastal Plain supports a rich flora, which includes a diverse collection of lycophytes, monilophytes, and gymnosperms. Fifty-seven (57) species and varieties of native and non-native lycophytes and monilophytes, and 12 species and varieties of native and non-native gymnosperms are reported here. This paper presents all taxa known to occur from these three groups on the Delmarva Peninsula in the form of an annotated checklist. These data provide the most accurate and up-to-date information on the distribution and status for all taxa listed, and adds to the overall knowledge of the Atlantic Coastal Plain flora.

INTRODUCTION

Unique and distinctive components of the flora of most regions include the spore-bearing vascular plants (lycophytes or clubmosses, spikemosses, and quillworts, and monilophytes or true ferns), and the non-flowering seed plants (gymnosperms including hemlock, pine, cypress, cedar). Members of these three groups are easily recognized and usually can be identified even by the inexperienced; they are frequently found in a variety of habitat types, and often form the basis for classifying plant communities. The Delmarva Peninsula, a unique geographic area of the Atlantic Coastal Plain province of the eastern U.S., supports a rich and diverse flora of over 2,400 species and varieties of native and naturalized vascular plants (McAvoy 2000). Important elements of this flora are the lycophytes, monilophytes, and gymnosperms, for which 57 species and varieties of native and non-native lycophytes and monilophytes and 12 species and varieties of native and non-native gymnosperms are known. The purpose of this paper is to present all taxa known to occur from these three groups on the Delmarva Peninsula in the form of an annotated checklist. When research for this checklist began in 1997, the intent was to base each species occurrence, as much as possible, on modern day (less than 20 years old) collections, in order to provide the most accurate and up-to-date distribution and status for each taxon listed. Researchers will now have at their disposal a document that should aid in their studies, as well as add to the overall knowledge of the Atlantic Coastal Plain flora and help to outline the phytogeography of the province.

Traditionally, botanists referred to two groups of spore-bearing plants as the “ferns” and “fern-allies,” and in most classifications, they were formally placed within the division Pteridophyta and were collectively referred to as Pteridophytes. But new

research (Hasebe et al. 1995, Manhart 1995, Pryer et al. 1995, Wolf et al. 1998, Pryer et al. 2001, Pryer et al. 2004) focusing on phylogenetic relationships has resulted in changes to the classification system of the ferns and their relatives. The current classification is based on new evidence derived from molecular and morphological studies and from the fossil record. It is now commonly agreed that it is more appropriate to refer to the fern and fern-related groups as Lycophyta (clubmosses, spikemosses, and quillworts) and Monilophyta (true ferns and horsetails). The Lycophytes comprise three main orders (Pryer et al. 2004): Lycopodiales (clubmosses), Selaginellales (spikemosses), and Isoetales (quillworts). The Monilophytes comprise five main orders (Pryer et al. 2004): Psilotales (whisk ferns), Ophioglossales (ohioglossoid ferns), Equisetales (horsetails), Marattiales (marattioid ferns), and Polypodiales (leptosporangiate ferns). The Lycophyta are quite distinct from the Monilophyta and appear to have diverged early (early-mid Devonian, ca. 400 million years ago; Pryer 2004) and are thus not as closely related to the true ferns as botanists once thought. Furthermore, the horsetails (Equisetales) are now thought to be much more closely related to the true ferns than to any of the “fern-allies” (Pryer et al. 2001). Although the monilophytes and lycophytes are not as closely related as once believed, they do share a common trait in that both groups reproduce by spores.

THE STUDY AREA

The Delmarva Peninsula (Fig. 1) is an area lying entirely within the Atlantic Coastal Plain physiographic province of the eastern United States. The Peninsula lies south of the fall line (a term applied to the boundary between the Appalachian Piedmont province and the Atlantic Coastal Plain) in New Castle County, Delaware and Cecil County, Maryland, and is bordered on the east by the Delaware River, Delaware Bay and the Atlantic Ocean, and on the west by the Elk River and Chesapeake Bay. It includes the Coastal Plain province of Delaware (New Castle, Kent, and Sussex Counties), the Eastern Shore of Maryland (Cecil, Kent, Queen Anne's, Caroline, Talbot, Dorchester, Wicomico, Somerset, and Worcester Counties), and the Eastern Shore of Virginia (Accomack and Northampton Counties). Its length north to south is about 200 miles (320 km), its greatest width is about 70 miles (110 km), its narrowest width is about 10 miles (16 km), and the total land area is about 5,800 square miles (15,000 squared kilometers). The climate of the Peninsula is moderated by the Delaware Bay, Chesapeake Bay, and the Atlantic Ocean and is characterized by cool winters and warm humid summers. The landscape of Delmarva is mostly agriculture, on flat to gentle sloping sandy plains with slow-flowing rivers and streams that are bordered by extensive swamp forests and tidal marshes. In the coastal areas, barrier islands, salt marshes, tidal flats and inland bays are well developed. Delmarva's Coastal Plain soils of sands, silts, clays and gravel support forests primarily composed of mixed evergreen (loblolly pine, American holly) and deciduous tree species (oak, hickory, beech, gums, maple, tulip poplar). The Delmarva Peninsula lies within the Chesapeake Bay Lowlands Ecoregion as defined by The Nature Conservancy (2002), and within the Outer Coastal Plain Mixed Forest Province as mapped by Bailey (1995).

DELMARVA SPORE-BEARING AND GYMNOSPERM PLANTS

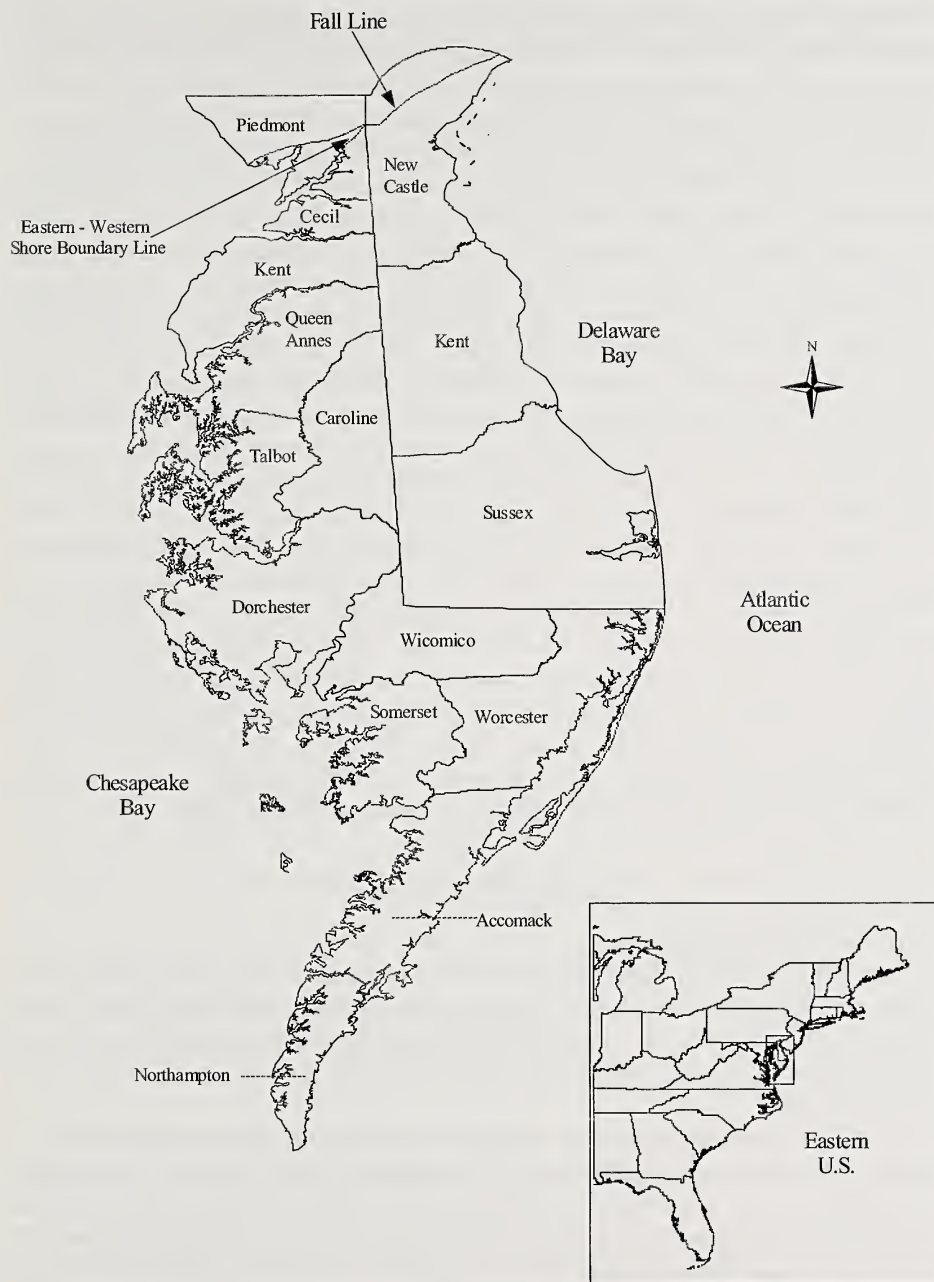


Figure 1. Location map and counties of the Delmarva Peninsula.

METHODS

The goal of this study was to base each species occurrence, as much as possible, on modern day (less than 20 years old) collections in order to provide the most accurate and up-to-date distribution and status for all taxa listed. Therefore, this

checklist is based primarily on field work and voucher specimens made by the author between 1992 and 2006. All voucher specimens made by the author have been deposited at DOV (herbarium acronyms follow Holmgren et al. 1990). Data were also gathered from the literature and from herbaria searches. Herbaria searched included: BALT, DOV, DUKE, FARM, GH, GMUF, MARY, MO, NY, ODU, PH, REED (now at MO), US, VPI, and WILLI. Additional data were kindly shared by other botanists who are currently working in the field on Delmarva, or have done field work in the recent past (Allen Belden, Pete Bowman, Janet Ebert, Gary Fleming, Chris Frye, Jason Harrison, Frank Hirst, Jack Holt, Wes Knapp, Rob Naczi, Mat Sarver, Pete Stango, Johnny Townsend, Ron Wilson, and Tom Wieboldt). Much field time was spent trying to relocate historical (greater than 20 years) locations for collections of uncommon taxa, as well searching counties for literature reports not supported by voucher specimens. When a taxon reported from a particular county on the Delmarva could not be relocated in the field by the author, other collections were utilized as vouchers, either modern day or historical. The oldest modern day collection of a lycophyte or monilophyte utilized as a county voucher is from 1988 of *Selaginella apoda* (Dorchester County, Maryland; *S. Hill 19511*, MARY). The oldest modern day collection of a gymnosperm utilized as a county voucher is from 1992 of *Taxodium distichum* (Sussex Co., Del., *W. McAvoy 932*, DOV). The oldest historical collection of a lycophyte or monilophyte utilized as a county voucher is from 1874 of *Pleopeltis polypodioides* subsp. *michauxiana* (Sussex County, Delaware, *A. Commons s.n.*, PH). The oldest historical collection of a gymnosperm utilized as a county voucher is from 1867 of *Chamaecyparis thyoides* (New Castle County, Delaware, *A. Commons s.n.*, PH). Often, unvouchered literature reports of certain taxa from particular counties could not be found in the field. In these cases, special notation is used in the text.

SUMMATION OF THE FLORA

Lycophyta and Monilophyta

The lycophytes and monilophytes are not as closely related as once thought, but they both share a common trait in that they reproduce by spores and thus form a distinctive component of the vascular flora of the Delmarva Peninsula. Therefore, the following results usually combine data for both the Lycophyta and Monilophyta, with some exceptions.

The results of this study show a total of 57 species and sub-species (49 species, 8 sub-species) of both native (55 taxa) and non-native (2 taxa) lycophytes and monilophytes (does not include hybrids), that have been vouchered with modern day (less than 20 years) and historical (greater than 20 years) collections (Table 1). Overall, 17 families are represented, composed of 36 genera. A total of 6 hybrids have been documented from both groups. Thirty-two taxa, or 56% of the native lycophytes (7 taxa) and monilophytes (25 taxa) are considered by the author to be either rare, or infrequent on the Delmarva Peninsula. Thirty-three percent (19 taxa) of the native lycophytes (6 taxa) and monilophytes (13 taxa) of Delmarva have a more northern overall distribution, and 14% (8 taxa) of the native lycophytes (1 taxon) and monilophytes (7 taxa) have a more southern overall distribution (Table 1). The largest families of lycophytes and monilophytes represented on Delmarva are: Lycophyta -

Table 1. Summary of Divisions Lycophyta and Monilophyta of the Delmarva Peninsula, including some data as a percentage (%) of the overall lycophyte and monilophyte flora.

Classification	Lycophyta	Monilophyta	Totals
Taxa	11	46	57
Species	11	38	49
Sub-species	0	8	8
Native taxa	11	44	55
Non-native taxa	0	2	2
Families	3	14	17
Genera	7	29	36
Hybrids	1	5	6
Rare or Infrequent	7	25	32 (56%)
Northern Native Taxa	6	13	19 (33%)
Southern Native Taxa	1	7	8 (14%)

Lycopodiaceae (7 taxa); Monilophyta - Dryopteridaceae (15 taxa), Ophioglossaceae (6 taxa), and Thelypteridaceae (4 taxa). The largest genera of lycophytes and monilophytes are: Lycophyta - *Isoetes* (3 taxa); Monilophyta - *Dryopteris* (7 taxa), *Equisetum* (3 taxa), *Osmunda* (3 taxa), and *Sceptridium* (3 taxa). Table 2 shows the diversity of lycophytes and monilophytes (native and non-hybrid; 55 taxa) on the Delmarva by county, with New Castle having the greatest number of taxa, 45 (82% of the flora), and Somerset having the lowest number, 28 (51% of the flora). Twenty taxa, or 37% of the native, non-hybrid lycophytes and monilophytes of the Delmarva have been documented from all counties on the Peninsula (Table 3).

Gymnosperms

The gymnosperm flora of Delmarva consists of a total of 12 taxa (11 species and 1 sub-species), both native (9 taxa) and non-native (3 taxa) that have been vouchered with modern day and historical collections (Table 4). Two families are represented, composed of 5 genera. Thirty-six percent of the native gymnosperm flora (5 taxa) is considered by the author to be either rare or infrequent on the Delmarva Peninsula. Fifty-six percent (5 taxa) of the native gymnosperm flora of Delmarva has a more southern overall distribution, and 22% (2 taxa) of the native gymnosperm flora has a more northern overall distribution (Table 4). The largest gymnosperm families containing native and non-native taxa represented on Delmarva are: Pinaceae (9 taxa), and Cupressaceae (3 taxa). The largest gymnosperm genus is *Pinus* with 8 taxa, with five being native and three being non-native. The highest diversity of native gymnosperms (9 taxa) on Delmarva by county, are found in Wicomico and Worcester, both

Table 2. Total number of native and non-hybrid lycophytes and monilophytes combined, by county on the Delmarva Peninsula (from lowest to highest), and as a percentage of the overall native, non-hybrid flora (55 taxa).

County	Total taxa	Percentage
Somerset	28	51
Northampton	30	54
Queen Anne's	32	58
Accomack	34	62
Cecil	35	64
Talbot	35	64
Wicomico	35	64
Dorchester	36	65
Kent, Md.	36	65
Kent, Del.	36	65
Worcester	38	69
Caroline	41	75
Sussex	44	80
New Castle	45	82

with 8 taxa (89% of the gymnosperm flora). Cecil County has the lowest number of native gymnosperms with 3 (33% of the gymnosperm flora). Two taxa (*Juniperus virginiana* and *Pinus virginiana*), or 22% of the native gymnosperm flora of Delmarva have been documented from all counties on the Peninsula.

DISCUSSION

Prior to this study, the most extensive research on the lycophytes and monilophytes of the Delmarva Peninsula, were conducted by Tatnall (1946; covering all Delmarva Counties), Reed (1953; covering Delaware and Maryland Counties), Reed (1960; covering Virginia Counties and the Maryland Counties of Worcester and Somerset), Redman (1991; covering Maryland Counties)], Harvill et al. (1992; covering Virginia Counties), and McAvoy & Bennett (2001; covering Delaware Counties). Studies of the gymnosperms of Delmarva were made by Tatnall (1946; covering Delmarva Counties), Taber (1960; covering Delaware Counties), Harvill et al. (1992; covering Virginia Counties), and McAvoy & Bennett (2001; covering Delaware Counties). Of these authors, Tatnall (1946) was the only one to develop a

Table 3. The lycophytes and monilophytes documented (modern and historical collections) from all counties on the Delmarva Peninsula.

Scientific Name
Lycophyta
<i>Dendrolycopodium obscurum</i>
<i>Diphasiastrum digitatum</i>
Monilophyta
<i>Asplenium platyneuron</i>
<i>Athyrium filix-femina</i> var. <i>angustum</i>
<i>Athyrium filix-femina</i> var. <i>asplenioides</i>
<i>Botrypus virginianus</i>
<i>Dennstaedtia punctilobula</i>
<i>Dryopteris carthusiana</i>
<i>Equisetum arvense</i>
<i>Onoclea sensibilis</i>
<i>Osmunda cinnamomea</i>
<i>Osmunda regalis</i> var. <i>spectabilis</i>
<i>Parathelypteris noveboracensis</i>
<i>Polystichum acrostichoides</i>
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>
<i>Sceptridium bitermum</i>
<i>Sceptridium dissectum</i>
<i>Thelypteris palustris</i> var. <i>pubescens</i>
<i>Woodwardia areolata</i>
<i>Woodwardia virginica</i>

floristic checklist, which included lycophytes, monilophytes, and gymnosperms for the whole of the Delmarva. Though Tatnall was the only author to study the flora of the Delmarva overall, all of the former efforts mentioned have contributed to our floristic knowledge of the lycophytes, monilophytes, and gymnosperms of the Delmarva and provide an historical foundation for this study. In addition, these earlier works allow for comparisons to be made between the later day and present day flora.

Table 4. Summary of the gymnosperm (Coniferophyta) taxa (i.e., recognized species and sub-species) of the Delmarva Peninsula, including some data as a percentage of the overall Gymnosperm flora.

Classification	Number
Taxa (native & non-native)	12
Species	11
Sub-species	1
Native taxa	9
Non-native taxa	3
Families	2
Genera	5
Rare or infrequent taxa	5 (36%)
Southern native taxa	5 (56%)
Northern native taxa	2 (22%)

It should be noted that Tatnall (1946) included the Piedmont physiographic province of New Castle County, Delaware and Cecil County, Maryland within his definition of the Delmarva Peninsula. Tatnall defines the Delmarva as being strictly Coastal Plain. Geologically, a peninsula is defined as a body of land surrounded by water and narrowly connected to a mainland (Hamblin 1985), the mainland in this case being the Piedmont of New Castle and Cecil Counties. Major differences in soils, hydrology and floristics are unquestionable between the Piedmont and Coastal Plain provinces; thus, the Delmarva Peninsula is defined here as one distinct geographic, geologic, and ecologic entity. While comparing Tatnall's (1946) checklist with this study, care was taken to exclude all Piedmont records from the analysis.

Table 6 shows the number of native and non-native lycophytes and monilophytes (excluding hybrids and forms) reported by Tatnall (1946), Reed (1953, 1960), Redman (1991), Harvill et al. (1992), and McAvoy & Bennett (2001), compared to the number of native and non-native lycophytes and monilophytes (excluding hybrids and forms) reported from this study. It should be noted that the taxonomic concepts employed by these earlier authors, updated to contemporary standards, often result in a reduction in the number of species they listed. For example, Tatnall (1946) listed 51 species and varieties of "ferns" and "fern-allies" (excluding hybrids and forms), but following the nomenclature used in this study, 6 would be "lumped" with other species or varieties.

In general, this study provides the most extensive list of the lycophyte and monilophyte flora of the Delmarva to date. Reed (1953) focused only on the Delaware and Maryland counties of the Delmarva and reported 43 taxa from Maryland counties

Table 5. The total native gymnosperm flora, by county on the Delmarva Peninsula (lowest to the highest), and as a percentage of the overall native flora (9 taxa).

County	Totals [% of the native flora (9 taxa)]
Cecil	3 (33%)
Northampton	4 (44%)
Kent, Maryland	4 (44%)
Queen Anne's	4 (44%)
Somerset	4 (44%)
Talbot	4 (44%)
Dorchester	5 (56%)
Kent, Del.	5 (56%)
New Castle	6 (67%)
Sussex	7 (78%)
Wicomico	8 (89%)
Worcester	8 (89%)

and 44 from Delaware counties. This study lists 53 taxa from Delaware counties and 50 from Maryland counties (Table 6; two taxa Reed listed in 1953 are now placed in synonymy in this checklist). In 1960, Reed turned his attention to the Virginia counties of the Delmarva and reported 30 taxa; here 37 taxa are listed from Virginia Counties (Table 6; one taxon Reed listed is now placed in synonymy in this checklist). Redman (1991) listed the known lycophytes and monilophytes in Maryland and reported 46 taxa from Maryland's Eastern Shore counties of the Delmarva, compared to 50 listed in this study (Table 6). In Harvill's (1992) checklist of the flora of Virginia, he reported 30 taxa from the state's Eastern Shore counties of the Delmarva (Table 6), here 37 taxa are listed from the same counties (Table 6). Finally, McAvoy & Bennett (2001) listed 53 taxa from the Delaware counties of the Delmarva, as does this study (Table 6).

Table 7 lists 12 species of native and non-native lycophytes and monilophytes that are listed in this checklist, but were not reported by Tatnall in his 1946 publication (excludes hybrids and forms). Of these 12 species, 7 are reported here as new additions to the flora of the Delmarva Peninsula based on Reed (1953, 1960), Redman (1991), Harvill et al. (1992) and McAvoy & Bennett (2001). *Sceptridium oneidense* (Dorchester Co.) and *Botrychium matricariifolium* (Accomack Co.) were first reported by Reed (1953) and Reed (1956), respectively. Redman (1991) also listed *S. oneidense* based on Reed's collection, and Harvill et al. (1992) listed *B. matricariifolium*, also based on

Table 6. Comparison of the number of native and non-native taxa (excluding hybrids and forms) listed from previous studies on the lycophyte and monilophyte flora of Delmarva, with the number of taxa listed in this study. A question mark (?) indicates that these data could not be accurately determined due to the author's format of describing distribution data.

Authors	Delmarva	Delaware Counties	Maryland Counties	Virginia Counties
McAvoy (2006)	57	53	50	37
McAvoy & Bennett (2001)		53		
Tatnall (1946)	51	?	?	?
Reed (1953)		44	43	
Reed (1960)				30
Redman (1991)			46	
Harvill (1992)				30

Reed's collection. *Asplenium rhizophyllum* and *Pellaea atropurpurea* were first reported by Hadaway (1992), and *Schizaea pusilla* was first reported by Hirst (1990).

The gymnosperms of Delmarva were studied by Tatnall (1946), Taber (1960), Harvill et al. (1992), and McAvoy & Bennett (2001). Table 8 shows the number of gymnosperms reported by these authors, compared to the number of gymnosperms listed in this study. This study lists 12 gymnosperms compared to Tatnall (1946), who reported 10. Taber (1960), who only studied the gymnosperms of Delaware, also reported 10 taxa, and Harvill et al. (1992), who was only concerned with the Virginia counties of the Delmarva, reported five. The two species reported here that were not listed by Tatnall (1946), Taber (1960) and Harvill et al. (1992) are: *Pinus thunbergiana* and *Pinus palustris*, both of which are not native to the Delmarva. Harvill et al. (1992) did not list *Chamaecyparis thyoides* from Virginia counties of the Delmarva, and McAvoy & Bennett (2001) did not list *P. palustris* from Delaware counties.

Comparing the species diversity of the native lycophyte and monilophyte flora (excluding hybrids and forms) of Delmarva with other Atlantic Coastal Plain States (New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Georgia; Atlantic Coastal Plain boundaries follow USGS 2004) and regions (Cape Cod, Massachusetts, and Long Island, New York), we find that Long Island supports the highest number of native taxa with 58, followed by New Jersey with 56, then Virginia and the Delmarva Peninsula, both with 55 taxa (Table 9).

Table 9 compares the percentage of the overall native lycophyte and monilophyte floras (excluding hybrids and forms) of Atlantic Coastal Plain States and regions that are primarily either southern or northern in distribution (defined as species that have the core of their distribution either in the southern or northern states or provinces based on FNA 1993). The native lycophyte and monilophyte flora of Delmarva is

Table 7. Native and non-native lycophytes and monilophytes (excluding hybrids and forms) listed in this study, but not reported by Tatnall (1946) with comments on other reports.

Species	Comments
<i>Azolla caroliniana</i> (non-native)	
<i>Asplenium rhizophyllum</i>	first reported by Hadaway (1992)
<i>Botrychium matricariifolium</i>	first reported by Reed (1956)
<i>Cystopteris protrusa</i>	
<i>Diplazium pycnocarpon</i>	
<i>Dryopteris clintoniana</i>	
<i>Dryopteris goldiana</i>	
<i>Isoetes echinospora</i>	
<i>Marsilea quadrifolia</i> (non-native)	
<i>Pellaea atropurpurea</i>	first reported by Hadaway (1992)
<i>Sceptridium oneidense</i>	first reported by Reed (1953)
<i>Schizaea pusilla</i>	first reported by Hirst (1990)

primarily northern in its biogeographic affinity, with 33% of the flora having a more northern distribution, compared to 14% of the flora that is more southern in distribution. As one travels north to south on the Atlantic Coastal Plain, the native lycophyte and monilophyte flora becomes much more southern in origin. Only 5% and 10% of the flora of Long Island and Cape Cod, respectively, have a more southern distribution. In contrast, the floras of South Carolina and Georgia includes only 4% and 0% northern element, respectively. The native lycophyte and monilophyte flora of Virginia appears to be transitional, with 24% of its flora being southern, and 22% being northern. South of Virginia, the northern lycophyte and monilophyte flora drops by 12%. North of Virginia, the southern monilophyte and lycophyte flora drops by 10%.

Comparing the species diversity of the native gymnosperm flora of Delmarva with other Atlantic Coastal Plain States (New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Georgia) and regions (Cape Cod and Long Island), Delmarva supports 9 taxa of native gymnosperms, while Cape Cod supports 6, the fewest within the Atlantic Coastal Plain, and South Carolina supports 14 taxa, the greatest number (Table 10). Traveling north to south on the Atlantic Coastal Plain province, the diversity of gymnosperms appears to increase (Table 10). In Cape Cod, 6 native gymnosperms occur, and in New Jersey 7 native gymnosperms are found. In contrast, Georgia and South Carolina support 13 and 14 native gymnosperms respectively.

Table 8. Numbers of native and non-native gymnosperms listed from previous Delmarva studies [Tatnall (1946); Taber (1960); Harvill et al. (1992); and McAvoy & Bennett (2001)], with the number of gymnosperms listed in this study. A question mark (?) indicates that these data could not be accurately determined due to the author's format of describing distribution data.

Authors	Delmarva	Delaware Counties	Maryland Counties	Virginia Counties
McAvoy (this study)	12	12	12	6
McAvoy & Bennett (2001)		11		
Tatnall (1946)	10	?	?	?
Taber (1960)		10		
Harvill (1992)				5

ANNOTATED CHECKLIST OF THE LYCOPHYTES, MONILOPHYTES, AND GYMNOSPERMS OF THE DELMARVA PENINSULA

Text Arrangement and Format

The division Lycophyta is listed first, followed by division Monilophyta, and ending with the gymnosperms (division Coniferophyta). Division, order, families, genera and species are arranged phylogenetically. The phylogenetic order of arrangement for the Lycophyta and Monilophyta follows both Pryer et al. (2004) and the Flora of North America Editorial Committee [FNA (1993)]. The phylogenetic order of arrangement for the gymnosperms follows FNA (1993). For the most part, nomenclature for the Lycophyta and Monilophyta follows FNA (1993). When names listed in FNA (1993) are not accepted, the following sources are recognized: Lycopodiaceae (Haines 2003); Ophioglossaceae (Kato 1987; Hauk 1996; Hauk, Parks, & Chase 2003); Thelypteridaceae (Holttum 1976; Smith & Cranfill 2002). Nomenclature for the gymnosperms primarily follows FNA (1993), with the exception of the genus *Taxodium*, which follows Weakley (2006). Each taxon listed may or may not be followed by one or more synonyms, and names used by Reed (1953, 1960), Tatnall (1946) and FNA [1993; when not recognized) are also provided. Common names are based on McAvoy & Bennett (2001). Unless otherwise noted, the overall North American distribution (north of Mexico) is based on FNA (1993; state and provincial acronyms also follow FNA). If the core of a taxon's range is primarily northern or southern, then that is noted in the North American distribution field (e.g., **N.A. Distribution:** northern; Nfld. nw. to Alaska, s. to Oreg., e. to Del. and Md.). This indicates that the taxon is at or near the southern limits of its natural geographic distribution on the Delmarva Peninsula. The Delmarva Peninsula distribution of a taxon is listed first by state [Del. (Delaware), Md. (Maryland), and Va. (Virginia)], then by the counties within each state going from north to south (e.g., **Delmarva Distribution:** **Del.:** New Castle; Kent; Sussex. **Md.:** Cecil; Kent; Queen Anne's; Caroline; Talbot; Dorchester; Wicomico; Somerset; Worcester. **Va.:** Accomack;

Table 9. Total Taxa and percentage of the native Coastal Plain lycophyte and monilophyte floras (excluding hybrids and forms) that are southern and northern (overall distribution data based on FNA 1993) to the Delmarva Peninsula. Data from the state of Delaware is not included here because the state's Coastal Plain province is included within the Delmarva Peninsula in its entirety. State and regional flora data are based on: Cape Cod, Massachusetts-Sorrie & Somers (1999); Long Island, New York-Weldy & Werier (2005); New Jersey-Montgomery & Fairbrothers (1992); Maryland-Redman (1991); Virginia, North Carolina, South Carolina, and Georgia-Weakley (2006).

State/Region	Total	% of Flora Southern	% of Flora Northern
Long Island, New York	58	5	52
Cape Cod, Massachusetts	44	10	48
New Jersey	56	13	45
Maryland	48	13	33
Delmarva Peninsula	55	14	33
Virginia	55	24	22
North Carolina	52	37	10
South Carolina	54	44	4
Georgia	53	70	0

Northampton). If a taxon is listed for a state and county, then it has been vouchered with a modern day (within the last 20 years) collection by the author, unless otherwise noted [e.g., *F. Hirst* (collector's last name), ## (collection number), 2003 (year of collection), DOV (herbarium where deposited)]. A county record has been vouchered by at least one collection, but in most cases several collections exist, both modern day and historical. Since the majority of county voucher specimens were collected by the author, collection data (year, number, herbarium) are not listed in order to save space (the author's collection data are available upon request). If a taxon has been reported from a county based on the literature (LIT.) and no voucher specimen has been seen by the author, then the literature citation is given (e.g., Reed 1953), followed by *nss*, (no specimen seen). For example, **Md.:** Cecil, LIT. (Reed 1953, *nss*). If a county of occurrence is historical (HIST.; not collected or reported for more than 20 years), or extirpated (EXT.; gone from a county or the Delmarva) then the name of the person to make the last collection, collection number, collection year, and herbarium where deposited is given [e.g., **Md.:** Cecil, HIST. or EXT. (*B. Long*, 57072, 1941, PH)]. If a taxon has been vouchered from all counties on the Delmarva with a modern day collection by the author, then the entry is: All Counties. The status of a taxon refers to its relative rarity on the Delmarva Peninsula and is based on the collection record, the literature, and the personal field experience of the author. The following terms are used to describe the status of a taxon on the Delmarva: Rare (known from only a few

Table 10. Native gymnosperm flora of Atlantic Coastal Plain States (Massachusetts, New Jersey, Maryland, Virginia, North Carolina, South Carolina and Georgia) and regions (Cape Cod, MA and Long Island, NY) to the Delmarva Peninsula. Data from the state of Delaware is not included here because the state's Coastal Plain province is included within the Delmarva Peninsula in its entirety. State and regional flora comparisons of the Gymnosperms are based on: Cape Cod, MA (Sorrie & Somers 1999); Long Island, NY (Weldy & Werier 2005); New Jersey (Stone 1911); Maryland (Brown & Brown 1972); Virginia, North Carolina, South Carolina, and Georgia (Weakley 2006).

State/Region	Total Native Taxa
Cape Cod, MA	6
New Jersey	7
Long Island, NY	8
Delmarva	9
Maryland	9
North Carolina	10
Virginia	11
Georgia	13
South Carolina	14

populations); Infrequent (occasionally encountered); Frequent (evenly distributed, but not plentiful); Common (plentiful throughout); Status Uncertain (field work and herbaria studies are needed to better understand the current distribution and abundance of the species). The duration of a taxon refers to its phenology, whether the foliage dies-back at the close of a growing season (deciduous) and reemerges the following season, or persists through the winter (evergreen) and develops new foliage the next season. The brief habitat description refers to the habitat preferences of a taxon on the Delmarva Peninsula, and is based on the collection record, the literature, and the personal field experience of the author. Comments are varied and are meant to provide useful information related to the taxon.

Division Lycophyta – Clubmosses, Spikemosses, and Quillworts

Order Lycopodiales – Clubmosses

Family Lycopodiaceae

***Huperzia lucidula* (Michx.) Trevis.**

Synonym(s): *Lycopodium lucidulum* Michx.

Common name(s): shining clubmoss

N.A. Distribution: northern; Nfld. nw. to se. Man., s. to the mountains of N.C. Tenn., Ga.,

Delmarva Distribution: All Counties, except Somerset and Northampton.

Delmarva Status, Duration, and Habitat: Frequent; evergreen; cool seepage slope wetlands and seepage swamps.

Comments: Species within the genus *Huperzia* have the ability to produce gemmae, which are miniature, 6-leaved plantlets that develop in a single whorl at the tip of the upright stem. Gemmae, which are spread by wind and water, potentially develop roots and grow into new plants. Gemmae usually mature by mid-to-late summer and are shed near the end of the growing season. The genus *Huperzia* is positioned near the base of the family tree within the Lycopodiaceae and contains characteristics distinct from other genera of the family, such as: there are no strobili (spore-bearing cones); sporophylls (spore-leaves) are borne in distinct zones on the upright stem; an elongated, horizontal stem does not develop; and gemmae are produced at the tip of mature plants. Therefore, Haines (2003) has placed *Huperzia* within a separate family, Huperziaceae.

***Lycopodium clavatum* L.**

Common name(s): staghorn clubmoss

N.A. Distribution: northern; Nfld. w. to Sask., se. to the mountains of W. Va., Va., N.C., Tenn., and also Alaska, s. to Calif.

Delmarva Distribution: Del.: New Castle; Kent; Sussex. Md.: Cecil; Caroline; Dorchester; Somerset; Worcester, HIST. [*F. Hirst s.n.*, 1979, DOV; (Hirst 1983)].

Delmarva Status, Duration, and Habitat: Infrequent to frequent; evergreen; open woods and thickets, successional habitats.

Comments: More frequently found in the northern counties (New Castle, Cecil), rare farther south.

***Dendrolycopodium obscurum* (L.) A. Haines**

Synonym(s): *Lycopodium obscurum* L.

Common name(s): tree clubmoss

N.A. Distribution: northern; N.S., Wis., s. to the mountains of Tenn., the Carolina's and ne. Ala.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; evergreen; moist to poorly drained woods, edges of swamps.

Comments: This species is common and widespread on Delmarva, but becomes very rare in Accomack and Northampton Counties. The genus *Dendrolycopodium*, which includes species formerly found within the *Lycopodium obscurum* complex (*L. dendroideum* Michx; *L. hickeyi* W. Wagner, Beitel & Moran; *L. juniperoideum* Spreng.; and *L. obscurum*), is now considered distinct (Haines 2003) from the type (*Lycopodium clavatum*) in several ways, but primarily by the upright, branched tree-like form and sessile, unstalked strobili. There are reports of *Dendrolycopodium hickeyi* (W.H. Wagner, Beitel, & Moran) A. Haines (*Lycopodium hickeyi*; *L. obscurum* var. *isophyllum* Hickey) from Delmarva, as well as specimens labeled as such (Somerset Co., *Prenger* 7, 1979, BALT; New Castle Co., *D.*

Redman 9235, 1998, BALT; Worcester Co., *Lauenstein 25*, 1970, BALT), but these specimens are not convincing enough to consider them as anything more than a growth or “sun” form of *D. obscurum* (these specimens have been annotated as *D. obscurum* by the author). I have seen populations of *D. obscurum* in the field that grade from shade to full-sun and assume an appearance of *D. hickeyi* (lateral shoots round in cross-section with all leaves the same length). The shade plants have the typical morphology of *D. obscurum* (lateral shoots flat in cross-section with leaves unequal in size), but as plants grow into the sun, branches become very erect (full-sun) and the lateral shoots appear round, but the leaves are all unequal in length.

***Diphasiastrum digitatum* (Dill. ex A. Braun) Holub**

Synonym(s): *Lycopodium complanatum* L. var. *flabelliforme* Fern.; *L. digitatum* Dill. ex A. Braun; *L. flabelliforme* Blanchard

Common name(s): running-pine clubmoss

N.A. Distribution: Nfld. to s. Ont., Wis., s. to n. Ala.

Delmarva Distribution: All Counties, but Historical in Northampton (*Honick 249*, 1975, ODU).

Delmarva Status, Duration, and Habitat: Common; evergreen; woods and thickets, successional habitats.

Comments: Common and often abundant in the northern counties of Delmarva, but becoming uncommon to rare farther south. This species is known from only one extant population in Accomack Co. and a single historical collection from Northampton County.

***Diphasiastrum tristachyum* (Pursh) Holub**

Synonym(s): *Lycopodium tristachyum* Pursh

Common name(s): ground-cedar clubmoss

N.A. Distribution: northern; Nfld. to se. Man., se. in the mountains to n. Ga.

Delmarva Distribution: Del.: New Castle; Kent; Sussex. Md.: Cecil; Caroline; Dorchester; Somerset; Wicomico; Worcester.

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; sandy woods and thickets, successional habitats.

Comments: Species is distinguished from *D. digitatum* by its deeply buried rhizomes and is often blue-green in color, but color will vary in sun or shade. In addition, this species can be distinguished from *D. digitatum* by the scale-like leaves on the underside of the branch, which are about the same length as the lateral branch leaves (underside branch leaves of *D. digitatum* are much shorter in length than the lateral branch leaves).

***Lycopodiella appressa* (Chapm.) Cranfill**

Synonym(s): *Lycopodium appressum* (Chapm.) Lloyd & Underw.; *L. chapmanii* Underw. ex Maxon; *L. inundatum* L. var. *appressum* Chapman; *L. inundatum* var. *bigelovii* Tuckerm.

Common name(s): appressed bog clubmoss

N.A. Distribution: Mostly Coastal Plain, Nfld., s. to Fla., w. to Tex.

Delmarva Distribution: **Del.:** New Castle; Kent; Sussex. **Md.:** Kent, HIST. (*S. Brown s.n.*, 1907, PH); Caroline; Dorchester, HIST. (*M. Brown & R. Brown s.n.*, 1962, MARY); Wicomico; Somerset, HIST. (*C. Reed 31717*, 1953, MO); Worcester. **Va.:** Accomack; Northampton, HIST. (*R. Tatnall 3766*, 1938, DOV).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; interdunal swales, peat bogs, acidic sandy/peaty swales, powerline bogs, clear-cut swales.

Comments: Most frequently found in south-central Delmarva (Sussex, Wicomico, and Worcester Counties), infrequent to rare in other regions of the Peninsula. The horizontal stems of this species lie flat on the ground and upright shoots have appressed leaves with few to no teeth on the margins. Horizontal shoots are evergreen, but upright shoots senesce and die-back in winter. Redmond (1932) listed *Lycopodium carolinianum* L. [= *Pseudolycopodiella caroliniana* (L.) Holub] as occurring on Delmarva from Worcester Co.: “in low places behind dunes, Fenwick Island” and “in low meadow east of Stockton.” Although this citation has persisted in the literature (Tatnall 1946, Reed 1952, Reed 1953, Redman 1991), no specimen has been found. Only Tatnall (1946) points out that “no specimen has been seen.” There are no other references, reports, or specimens of this species from Delmarva. The area that Redmond describes as “in low places behind dunes, Fenwick Island,” where he supposedly found *Pseudolycopodiella caroliniana*, must be an interdunal wetland (a unique non-tidal, freshwater depressional wetland); this habitat type occurs from the counties of Sussex to Accomack along Delmarva’s Atlantic coastal strand and barrier islands. A frequent inhabitant of this wetland type is *L. appressa*, so it is possible that Redmond confused *L. appressa* with *P. caroliniana*. The area that Redmond describes as “in low meadow east of Stockton” is outside of the distribution of the interdunal wetland type, but low meadows, or swales within the Stockton area could also support *L. appressa*. Redman did list *Lycopodium inundatum* [= *Lycopodiella inundata* (L.) Holub], apparently not based on his own personal observation, but based on Shreve’s (1910) citation related to his publication on the “Plant Life of Maryland.” Shreve obviously misapplied the name *L. inundatum* for *L. appressa* (*Lycopodiella inundata* is a more northern, circumboreal species that is found at higher elevations in the south). Without a voucher specimen, *P. caroliniana* is excluded from this checklist, however, it is not beyond the possibility that *P. caroliniana* could have occurred on Delmarva in the past, or could possibly still be extant. FNA (1993) gives the Atlantic coastal range of *P. caroliniana* as being from Florida to Massachusetts. The species is rare in southeast Virginia and also on the western shore of Maryland’s inner coastal plain, but is frequent in the pinelands of southern New Jersey. Perhaps the Delmarva gap in this species distribution will be filled in the future by some fortunate field botanist.

***Lycopodiella alopecuroides* (L.) Cranfill**

Synonym(s): *Lycopodium alopecuroides* L.

Common name(s): foxtail bog clubmoss

N.A. Distribution: southern; mostly on the Coastal Plain, e. Mass, Conn., R.I., Pa., s. to Fla., w. to Tex.

Delmarva Distribution: Del.: New Castle, HIST. (*C. Deakyne s.n.*, 1938, DOV); Kent; Sussex. Md.: Caroline; Dorchester; Wicomico (*W. Knapp 1568*, 2005, DOV); Worcester. Va.: Accomack; Northampton (*J. Townsend 2889*, 2002, WILLI).

Delmarva Status, Duration, and Habitat: Infrequent to frequent; evergreen; moist sandy/peaty swales in clear-cuts and power-lines;

Comments: Primarily of the southern counties on Delmarva, rare farther north. Arching, horizontal stems and spreading leaves of upright shoots are diagnostic field characters. Horizontal shoots are evergreen, but upright shoots senesce and die-back in winter.

***Lycopodiella xcopelandii* (Eig.) Cranfill (*L. alopecuroides* x *appressa*)**

Synonym(s): *Lycopodium alopecuroides* L. var. *elongatum* (Chapm.) Chapm.; *L. inundatum* L. var. *elongatum* Chapm.; *L. inundatum* var. *robustum* R.J. Eaton (*in Reed 1953*)

Common name(s): hybrid bog clubmoss

N.A. Distribution: Coastal Plain, New England, s. to Fla., w. to Tex.

Delmarva Distribution: Del.: Sussex. Md.: Wicomico. Va.: Accomack.

Delmarva Status, Duration, and Habitat: Rare; evergreen; interdunal swales, peat bogs, acidic sandy/peaty swales on power-lines and clear-cuts.

Comments: Horizontal stems lie flat to somewhat arching on soil, with rooting at the ends and sometimes along the stem; leaves of upright shoots ascending to spreading with one or two pairs of teeth at the base. Perhaps not as rare as current data suggests; to be sought in counties where the two parents are known to occur.

Order Selaginellales – Spikemosses

Family Selaginellaceae

***Selaginella apoda* (L.) Spring**

Common name(s): meadow spikemoss

N.A. Distribution: s. Maine, to ne. Ky., Ohio, s. to Fla., w. to e. Tex.,

Delmarva Distribution: Del.: New Castle; Sussex. Md.: Cecil, HIST. (*N. Seyfried s.n.*, 1982, DOV); Kent, LIT. (Redman 1991, *nss*); Queen Anne's, LIT. (Redman 1991, *nss*); Caroline, HIST. (*E. Wherry s.n.*, 1938, PH); Talbot, HIST. (*E. Earle 4307*, 1946, PH); Dorchester; Wicomico, HIST. (*E. Wherry 3677*, 1936, PH); Somerset, LIT. (Reed 1953, *nss*; Redman 1991, *nss*); Worcester. Va.: Accomack.

Delmarva Status, Duration, and Habitat: Status uncertain; evergreen; acidic seepage bogs and swamps, wet meadows, moist edges.

Comments: The literature suggests that this species is widespread and common throughout its range; however, on Delmarva this species has been

difficult to find. Modern day, extant populations are represented by only 12 collections and the majority of these were made from relatively pristine, acidic seepage bogs and swamps.

Order Isoetales - Quillworts

Family Isoetaceae

Isoetes echinospora Dur.

Synonym(s): *I. echinospora* var. *braunii* (Dur.) Engelm.; *I. muricata* Dur.

Common name(s): spiny-spored quillwort

N.A. Distribution: northern; Lab., s. to N.J., n. Pa., nw. to Alaska, s. to n. Calif.

Delmarva Distribution: Del.: Sussex (*L. Musselman 99196*, 1999, ODU).

Delmarva Status, Duration, and Habitat: Rare; evergreen; amphibious, muddy banks and high gravel shores of shallow, freshwater tidal streams.

Comments: This species was first discovered on Delmarva in 1999 by Lytton Musselman and is currently known from a single, extant occurrence. This species may occur with *I. riparia* (discussed below), which it can easily be confused, but as the name indicates the mature spores of *I. echinospora* are ornamented with spines. Spores of all our *Isoetes* may be found around the base of the plant during much of the year, but plants collected in late summer usually contain well-developed spores, making identification easier. *Isoetes echinospora* should be sought in areas where *I. riparia* is known to occur.

Isoetes engelmannii A. Braun

Synonym(s): *I. engelmannii* var. *valida* Engelm.; *I. valida* (Engelm.) Clute

Common name(s): Engelmann's quillwort

N.A. Distribution: se. Ont., N.H., N.Y., s. to n. Fla., w. to Ala., se. Mo.

Delmarva Distribution: Del.: New Castle; Kent; Sussex, HIST. (*W. Canby s.n.*, 1893, DOV). **Md.:** Cecil; Kent; Caroline; Talbot; Dorchester (*W. Knapp 1570*, 2005, DOV); Worcester, HIST. (*W. Sipple s.n.*, 1985, DOV). **Va.:** Northampton, HIST. (*M. Fernald 5228*, 1935, PH).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; amphibious; intermittent stream beds with gravel bottoms, floodplain swales and oxbow sloughs.

Comments: Delmarva's most frequently occurring quillwort, but still uncommon.

Isoetes riparia Engelm. ex A. Braun

Synonym(s): *I. riparia* var. *palmeri* A.A. Eaton forma *saccharata* (Engelm.) Proctor (in Reed 1953); *I. saccharata* Engelm.

Common name(s): riverbank quillwort

N.A. Distribution: northern; s. Que., sw. Maine, s. through New England, Pa., N.J., s. to ne. N.C., disjunct in S.C. and Fla.

Delmarva Distribution: Del.: New Castle, EXT. (*W. Canby s.n.*, 1896, DOV); Sussex. **Md.:** Cecil; Kent; Queen Anne's, HIST. (*R. Tatnall 4094*,

1938, DOV); Caroline; Dorchester; Wicomico (*F. Hirst* 1226, 1998, DOV); Worcester.

Delmarva Status, Duration, and Habitat: Rare; evergreen; amphibious; restricted to exposed intertidal shores of freshwater rivers and creeks; on gravel, sand and mud substrates.

Comments: Considerable variation in spore morphology can be found in *I. riparia* and as a result, the species has had a long taxonomic history with many segregates being described that range from form to species; *I. riparia* is treated here as a single polymorphic species. *Isoetes riparia* is threatened on Delmarva from increased salinity levels, boat wake, shoreline stabilization, non-native invasive plants [*Hydrilla verticillata* (L. f.) Royle], and algal blooms. Dense mats of *Hydrilla* and algae will cover shorelines like a carpet during low tides and smother plants of *I. riparia*. Historically known in New Castle Co. from the Delaware River (near the city of Wilmington), now thought to be extirpated due to habitat degradation, pollution, and salt water intrusion.

Division Monilophyta – True Ferns

Order Ophioglossales – Rattlesnake Ferns, Grapeferns, Moonworts and Adder's-tongue

Family Ophioglossaceae

To aid in separating the Ophioglossoid genera described below, the following characters should be helpful. In addition, taxa within the Ophioglossaceae do not arise in the spring as coiled fiddleheads, but emerge erect from the ground, or in a bent form.

- a. The sporophore (fertile blade) and trophophore (sterile, leafy blade) are joined near, or below the soil surface; leaves evergreen *Sceptridium*
- a. Sporophore is joined just below the trophophore, or well above the soil surface; leaves deciduous b
- b. Plants usually less than 25 cm tall; trophophore fleshy in texture *Botrychium*
- b. Plants 25 to 50 cm tall; trophophore herbaceous in texture *Botrypus*

Botrypus virginianus (L.) Holub

Synonym(s): *Botrychium virginianum* (L.) Sw.

Common name(s): rattlesnake fern

N.A. Distribution: N.S., w. to s. Yukon, all States except California

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; moist woods with rich organic soils.

Comments: This species is a good indicator of Coastal Plain rich wood habitat. As traditionally circumscribed, the genus *Botrychium* was composed of three subgenera: *Botrychium*, *Sceptridium*, and *Osmundopteris* (= *Botrypus*), but Kato (1987), Hauk (1996), and Hauk et al. (2003) show that these subgenera should be recognized at the generic level based on molecular and morphological evidence.

***Sceptridium biternatum* (Sav.) Lyon**

Synonym(s): *Botrychium biternatum* (Sav.) Underw.; *B. dissectum* Spreng. var. *tenuifolium* (Underw.) Farw.; *B. tenuifolium* Underw.

Common name(s): southern grapefern

N.A. Distribution: southern; se. Pa., s. to W.Va., se. Mo., s. to Fla., w. to se. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Frequent; evergreen; moist to low woods and thickets.

Comments: This species has a southern distribution and is near its northern limit on Delmarva. *Sceptridium* is the only genus within Ophioglossaceae where the fronds emerge in mid-summer and remain green through the winter. *Sceptridium biternatum*, *S. dissectum*, and *S. oneidense* are all closely aligned and may grow together, so distinguishing between these taxa can be difficult. The leaflets of *S. biternatum* are elongate and nearly parallel-sided, with finely denticulate margins, little or no division, short-acuminate apex, and often with a contracted to cuneate base.

***Sceptridium dissectum* (Spreng.) Lyon**

Synonym(s): *Botrychium dissectum* Spreng.; *B. dissectum* var. *obliquum* (Muhl.) Clute; *B. obliquum* Muhl. in Willd.

Common name(s): cut-leaf grapefern

N.A. Distribution: N.S., se. Que., Wis., s. to Fla., w. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; evergreen; moist woods, swamps, floodplains, and thickets.

Comments: Two forms of *S. dissectum* exist on Delmarva: *S. dissectum* forma *obliquum* (Muhl.) Clute and *S. dissectum* forma *dissectum*. Forma *obliquum* is the most common, with trowel-shaped sub-leaflets, and forma *dissectum* is the extreme form with skeletonized leaflets cut into linear teeth. The two forms are often present within the same population. *S. dissectum* can be distinguished from other species of *Sceptridium* based on its leaflets which are obliquely trowel-shaped or linear, with denticulate to lacerate or coarsely cut margins, and acute apex.

***Sceptridium oneidense* (Gilbert) Holub**

Synonym(s): *Botrychium dissectum* Spreng. var. *oneidense* (Gilbert) Farw.; *B. dissectum* forma *oneidense* (Gilbert) Clute; *B. multifidum* (S.G. Gmelin) Ruprecht. var. *oneidense* (Gilbert) Farw.; *B. oneidense* (Gilbert) House

Common name(s): blunt-lobed grapefern

N.A. Distribution: northern; N.B., se. Que. and Ont., Mich., s. to the mountains of Va. and N.C.

Delmarva Distribution: Del.: Kent. Md.: Dorchester, HIST. (*C. Reed* 3869, 1945, MO). Va.: Northampton.

Delmarva Status, Duration, and Habitat: Rare; evergreen; swampy floodplain forests.

Comments: Due to its resemblance to *S. biternatum* and *S. dissectum*, this species is likely overlooked and may not be as rare as current data suggest. *S. oneidense* may be distinguished from other *Sceptridium* species based on its leaflets which are not lobed or only scarcely so, broad and obliquely ovate, with margins finely denticulate to rounded-serrate, and apex rounded to acute.

***Botrychium matricariifolium* (A. Braun ex Dowell) A. Braun ex Koch**

Common name(s): daisy-leaf moonwort

N.A. Distribution: northern; Nfld., Lab., N.S., Que., Ont., Minn., se. to w. N.C

Delmarva Distribution: Va.: Accomack, HIST. (*C. Reed* 36617, 1955, MO).

Delmarva Status, Duration, and Habitat: Rare; deciduous; moist rich tulip-poplar woods with a thin canopy.

Comments: A rare Coastal Plain occurrence (Reed 1956). The Accomack Co. population is the only known locale on Delmarva for this species, which has repeatedly been searched by the author for years without success. The plant appears in spring and its small size makes it difficult to find.

***Ophioglossum vulgatum* L.**

Synonym(s): *O. vulgatum* var. *pyncostichum* Fern.

Common name(s): southern adder's-tongue

N.A. Distribution: southern; Pa., s. to w. Fla., e. to Tex.

Delmarva Distribution: Del.: New Castle; Kent; Sussex. **Md.:** Cecil, LIT. (Reed, 1953, *nss.*; Redman 1991, *nss.*); Kent; Queen Anne's; Caroline; Talbot; Dorchester, HIST. (*Phillips* 16, 1977, DOV); Wicomico, LIT. (Redman, 1991, *nss.*); Somerset (*M. Sarver s.n.*, 2004, DOV); Worcester. **Va.:** Accomack; Northampton.

Delmarva Status, Duration, and Habitat: Infrequent; deciduous; moist thin woods often on rich soils, occasionally in low acid swales.

Order Equisetales – Horsetails

Family Equisetaceae

***Equisetum fluviatile* L.**

Common name(s): water horsetail

N.A. Distribution: northern; Nfld., nw. to Alaska, s. to Oreg., e. to Del. and Md.

Delmarva Distribution: Del.: New Castle. **Md.:** Kent (*P. Stango PS66SS*, 2003, DOV).

Delmarva Status, Duration, and Habitat: Rare; deciduous; seepage swamps and marshes on fresh tidal creeks.

Comments: Populations may contain stems that are both branched and unbranched. Stems late in the season, or following injury may produce regular whorls of branches that could cause confusion with *E. arvense*. The

stem cavity of *E. fluviatile* is 9/10 the diameter of stem, vs. stem cavity 2/3 diameter of stem for *E. arvense*. *Equisetum fluviatile* also occurs on the Western Shore of Md. in Cecil County. The hybrid horsetail *Equisetum xliorale* Kuhlewein ex Ruprecht (*E. arvense* x *fluviatile*) is reported in FNA (1993) for Delaware, but no specimen can be found and no other Delmarva reports of this hybrid are known in the literature. As in the Ophioglossaceae, taxa within the Equisetaceae do not arise in the spring as coiled fiddleheads, but emerge erect from the ground.

***Equisetum arvense* L.**

Common name(s): field horsetail

N.A. Distribution: Greenland, most of Canada, and all States except Fla., La, Miss., S.C.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Frequent; deciduous; speepage swamps, wet meadows, swales, ditches, roadsides.

Comments: This species is dimorphic (fronds or parts of fronds differentiated into fertile and sterile portions). The fertile, unbranched stems are yellow-brown in color and appear in early spring and wither by early summer. The vegetative stems are regularly branched, green in color and appear some time after the fertile stems.

***Equisetum hyemale* L. subsp. *affine* (Engelm.) Calder & Taylor**

Synonym(s): *E. prealtum* Raf.

Common name(s): scouring-rush horsetail

N.A. Distribution: N.B., west to B.C., and all U.S. States.

Delmarva Distribution: **Del.:** New Castle; Sussex. **Md.:** Cecil, LIT. (Reed 1953, *nss*; Redman 1991, *nss*); Kent, LIT. (Reed 1953, *nss*; Redman 1991, *nss*); Queen Anne's; Caroline; Talbot. **Va.:** Accomack (*G. Fleming 10066*, 1994, WILLI); Northampton (*A. Belden 2110*, 2005, VPI).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; primarily on steep wooded slopes above tidal rivers, but occasionally in thickets, edges, and moist swales.

Comments: *Equisetum hyemale* subsp. *hyemale* is found in Europe and Asia. From Cecil Co., I have only seen specimens (PH) of this species from the Piedmont province and Western Shore.

Order Osmundales – Cinnamon, Interrupted, and Royal Ferns

Family Osmundaceae

***Osmunda cinnamomea* L.**

Synonym(s): *O. cinnamomea* var. *frondosa* Gray; *O. cinnamomea* var. *glandulosa* Waters

Common name(s): cinnamon fern

N.A. Distribution: Lab., Nfld., e. Que., Minn., s. to Fla., w. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; swamps, floodplains, wet woods.

Comments: The variety *O. cinnamomea* var. *glandulosa* is recognized by some authors (e.g., Weakley 2006), and Reed (1953) cites this taxon from Kent Co. (Del.), but no specimen can be found at MO where Reed's collection now resides (George Yatskievych, pers. comm., 2006). Taxa within the Osmundaceae, as well as all families and taxa that follow, emerge in the spring as coiled fiddleheads.

***Osmunda claytoniana* L.**

Common name(s): interrupted fern

N.A. Distribution: northern; Lab., Nfld., e. Que., s. Ont., Minn., s. to N.C. and Tenn.

Delmarva Distribution: **Del.:** New Castle; Kent; Sussex. **Md.:** Cecil; Kent; Queen Anne's, HIST. (*C. Reed* 51355, 1961, US); Caroline (*J. Ebert & R. Holt* 99, 1998, DOV); Worcester, HIST. (*J. Potryai* 10, 1970, BALT). **Va.:** Accomack, HIST. (*R Tatnall* 4354, 1939, PH).

Delmarva Status, Duration, and Habitat: Infrequent; deciduous; moist deciduous woods (both rich and acid) and edges of swamps.

Comments: Most frequently encountered in the northern counties (New Castle, Cecil) of Delmarva, rare farther south. Although the Worcester specimen is correctly identified, its label data is suspect, due to the fact that suitable habitat simply does not exist where it was reported to be collected from, as well as for other reasons too complicated to detail. This species is often confused with cinnamon fern, but interrupted fern lacks the brown, woolly tufts of hair found on the cinnamon fern that appear at the junction of the leaflets and the rachis. The fertile leaflets of the interrupted fern develop in the middle of the blade, with sterile, vegetative leaflets above and below.

***Osmunda regalis* L. var. *spectabilis* (Willd.) Gray**

Common name(s): royal fern

N.A. Distribution: Nfld., s. Que. and Ont., Minn., s. to Fla., e. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; swamps, marshes, floodplains, low woods, interdunal wetlands.

Comments: *Osmunda regalis* var. *regalis* is widely distributed in Europe and Asia.

Order Schizaeales – Climbing Fern and Curly Grass Fern

Family Lygodiaceae - Climbing Ferns

***Lygodium palmatum* (Bernh.) Sw.**

Common name(s): climbing fern

N.A. Distribution: New England, s. to Ga., w. to Miss.

Delmarva Distribution: Del.: New Castle, EXT. (*R. Tatnall* 5002, 1942, DOV); Sussex. Md.: Kent, EXT. (*D. Redman* 9585, 1994, BALT); Wicomico, HIST. [*F. Hirst* s.n., 1981, DOV; (Hirst 1983)]; Worcester.

Delmarva Status, Duration, and Habitat: Rare; evergreen; thickets, open swampy floodplains, clearings, edges.

Comments: The literature indicates that this species is rare and local throughout much of its range. The sites in New Castle and Kent (Md.) Counties have been destroyed and the species is thought to be extirpated from both of these counties. At the two remaining extant populations on Delmarva (Sussex and Worcester Co.'s), the habitat for both are roadside thickets where the plants are climbing and twining over other vegetation.

Family Schizaeaceae - Curly Grass Ferns

Schizaea pusilla Pursh

Common name(s): curly-grass fern

N.A. Distribution: northern; Nfld., N.S., N.B., N.Y, N.J., Del.

Delmarva Distribution: Del.: Sussex.

Delmarva Status, Duration, and Habitat: Rare; evergreen; Atlantic white cedar swamp and bog.

Comments: Known from a single population on Delmarva, where it was first discovered by Frank Hirst and Ron Wilson in 1990 (Hirst 1990). A remarkable disjunct population of curly-grass fern has been reported from Peru (Stolze 1987).

Order Salviniaceae - Water-clover Ferns and Mosquito Ferns

Family Marsileaceae - Water-clovers

Marsilea quadrifolia L.

Common name(s): water-clover

N.A. Distribution: se. Ont., Maine, s. to Md., w. to Mo.

Delmarva Distribution: Del.: Sussex (*C. Martin* 10, 2000, DOV).

Comments: *Marsilea quadrifolia* is native to Europe and was introduced to North America about 1860 (Johnson 1993). This species is a rare non-native occurrence on the Peninsula and is currently known only from Sussex Co., where it was collected from a storm water retention pond. This species is known to form dense colonies in artificial impoundments, ponds, and sandpits, so it has the potential to become invasive. Leaflets are arranged like a four-leaf clover. A potential new introduction to Delmarva is *Marsilea mutica* Mett., which has been documented from southeast Virginia (Jacono & Johnson 2006) and is native to Australia and New Caledonia (Jacono & Johnson 2006). The leaflets of *M. mutica* are two-toned green, while the leaflets of *M. quadrifolia* are evenly green.

Family Azollaceae - Mosquito Ferns

Azolla caroliniana Willd.

Common name(s): eastern mosquito-fern

N.A. Distribution: southern; s. Ont., Minn., s. to Fla., w. to Tex.

Delmarva Distribution: Del.: New Castle; Kent; Sussex. Md.: Cecil; Dorchester (*J. Harrison*, 2006, photograph, MD Dept. of Nat. Res.); Wicomico; Worcester. Va.: Northampton.

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; floating in farm ponds, impoundments, headwaters of slow-moving freshwater tidal rivers and streams, and wetland depressions.

Comments: Considered to be adventive on Delmarva. This species is native to the southeast and was likely introduced initially on Delmarva through commercial crayfish farming and then subsequently spread by waterfowl. The mosquito-fern was first reported from Delmarva by Frank Hirst in 1978 from Worcester Co. (Hirst 1983). Populations appear to fluctuate in size from year to year and may disappear from a site altogether.

Order Polypodiales – Polypod Ferns

Family Dennstaedtiaceae - Bracken ferns

Dennstaedtia punctilobula (Michx.) T. Moore

Common name(s): hay-scented fern

N.A. Distribution: s. Nfld., Que., s. to se Va., sw. to Ala.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; dry to moist woods and slopes; often forming extensive, dense colonies.

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw. ex Heller

Synonym(s): *P. latiusculum* (Desv.) Fries

Common name(s): northern bracken fern

N.A. Distribution: Nfld., w. to se. Man., s. to Fla., w. to La.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; dry soils, edges, open sandy woods.

Comments: The genus *Pteridium* worldwide is composed of a single highly variable species and is represented on Delmarva by the northern variety *P. aquilinum* var. *latiusculum* and the southern variety *P. aquilinum* var. *pseudocaudatum*. The two tend to intergrade and distinction can sometimes be difficult. Northern variety: terminal sub-leaflets 2-4 times longer than wide, 3-6 mm wide. Southern variety: terminal sub-leaflets 6-15 times longer than wide, 2-5 mm wide.

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Heller

Common name(s): southern bracken fern

N.A. Distribution: southern; se. Maine, sw. to Ill., Ind., Ohio, s. to Fla., w. to e. Tex.

Delmarva Distribution: Del.: New Castle, HIST. (*R. Tatnall s.n.*, 1922, DOV); Sussex. Md.: Caroline; Dorchester; Wicomico; Somerset; Worcester. Va.: Accomack; Northampton.

Delmarva Status, Duration, and Habitat: Frequent; deciduous; dry soils, edges, open sandy woods.

Comments: Most frequently found in the southern counties of Delmarva, uncommon to rare farther north. Both varieties of the species are aggressive and can form extensive colonies in sun.

Family Pteridaceae – Maidenhair Ferns

Adiantum pedatum L.

Common name(s): common maidenhair fern

N.A. Distribution: N.S., se. Que and Ont., Minn., s. to n. Ga., w. to Okla.

Delmarva Distribution: Del.: New Castle; Kent. Md.: Caroline; Talbot; Dorchester.

Delmarva Status, Duration, and Habitat: Rare; deciduous; wooded ravines and slopes with moist, rich organic soils.

Pellaea atropurpurea (L.) Link

Common name(s): purple-stem cliff-brake

N.A. Distribution: s. Que. and Ont., Mich., Vt., s. to w. Fla., w. to Utah

Delmarva Distribution: Md.: Kent; Worcester (*R. Wilson*, 2003, photograph, pers. coll.).

Delmarva Status, Duration, and Habitat: Rare; evergreen; calcareous marl boulders and soil on steep cliff.

Comments: This species is rare throughout its range on the Coastal Plain and prefers limestone rocks and soils. It was first discovered on Delmarva by Eric Hadaway (Hadaway1992), where it grows with *Asplenium rhizophyllum*. The Worcester Co. occurrence grows in the crevices of an old stone wall with limestone mortar (Ron Wilson, pers. comm., 2003) and is considered to be adventive in this county due to its presence on an artificial substrate.

Family Aspleniaceae – Spleenworts

Asplenium rhizophyllum L.

Synonym(s): *Camptosorus rhizophyllus* (L.) Link

Common name(s): walking fern

N.A. Distribution: s. Ont., Que., Minn., s. to N.C., sw. to Ala.

Delmarva Distribution: Md.: Kent.

Delmarva Status, Duration, and Habitat: Rare; evergreen; calcareous marl boulders and soil on steep cliff.

Comments: The walking fern is primarily a plant of the Piedmont and Mountains where it prefers limestone rocks and soils, and is a rare occurrence on the Coastal Plain. This species is extant in the Piedmont of Maryland and historical in the Piedmont of Delaware. On Delmarva, this species was first discovered by Eric Hadaway (Hadaway 1992), growing on a steep cliff with calcareous marl boulders and soil that have been eroded and exposed by natural forces. Marl is a crumbly mixture of clays, calcium and magnesium carbonates and remnants of shells (Hamblin 1985).

***Asplenium platyneuron* (L.) B.S.P.**

Common name(s): ebony spleenwort

N.A. Distribution: s. Que., Ont., se. Wis., Maine, s. to Fla., w. to e. Tex., disjunct in Colo. and N. Mex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; evergreen; moist woods, open thickets, edges and clearings.

Comments: The sterile fronds of *A. platyneuron* are evergreen, while the fertile fronds are deciduous. A form of *A. platyneuron* with the leaf margins of the pinnae serrate, has been documented from Sussex and Queen Anne's Counties by the author. This form was recognized at the level of variety [*A. platyneuron* var. *incisum* (Howe) Robinson] by Reed (1953).

***Asplenium xebenoides* R.R. Scott (*A. platyneuron* x *rizophyllum*)**

Synonym(s): *Asplenosorus xebenoides* (R.R. Scott) Wherry

Common name(s): Scott's hybrid spleenwort

N.A. Distribution: Vt. to N.C., Ala. and Mo. (Montgomery & Fairbrothers 1992)

Delmarva Distribution: Md.: Kent.

Delmarva Status, Duration, and Habitat: Rare; evergreen; calcareous marl boulders and soil on steep cliff.

Comments: Rare at this single locale where both parents are found.

Family Thelypteridaceae - Marsh Ferns

***Parathelypteris noveboracensis* (L.) Ching**

Synonym(s): *Dryopteris noveboracensis* (L.) Gray; *Thelypteris noveboracensis* (L.) Nieuwl.

Common name(s): New York fern

N.A. Distribution: Nfld., se. Que. and Ont., Mich., s. to e. La.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; moist woods, swamps and floodplains.

Comments: Leaflets gradually become smaller towards the base and the veins of each sub-leaflet are simple, or not forked. The genus *Thelypteris* traditionally included subgenus, or section *Parathelypteris*, but research by Holttum (1976) and Smith & Cranfill (2002) has elevated the subgenus *Parathelypteris* to the level of genus.

***Parathelypteris simulata* (Davenp.) Holttum**

Synonym(s): *Dryopteris simulata* Davenp.; *Thelypteris simulata* (Davenp.) Nieuwl.

Common name(s): bog fern

N.A. Distribution: northern; N.S., N.B., se. Que. and Ont., Maine through New England, N.Y., e. central Pa., s. in the mountains to N.C., along the coast from Cape Cod to se. Va., disjunct in Wis.

Delmarva Distribution: **Del.:** Sussex. **Md.:** Caroline; Talbot, HIST. (*R. Tatnall* 3112, 1936, DOV); Wicomico, HIST. (*R. Tatnall* 3974, 1938, DOV); Worcester. **Va.:** Accomack, LIT. (Harvill et al. 1992, *nss*); Northampton.

Delmarva Status, Duration, and Habitat: Rare; deciduous; acidic seepage swamps, Atlantic white cedar swamps.

Comments: From Maryland south, *P. simulata* is found at high elevations and is infrequent to rare on the Coastal Plain. The specific epithet, *simulata*, refers to its resemblance to *P. noveboracensis* and *Thelypteris palustris* var. *pubescens*. The lower leaflets of *T. simulata* are somewhat reduced, but not greatly so as in *P. noveboracensis*. The veins of each sub-leaflet of *P. simulata* are simple, whereas the veins of *Thelypteris palustris* var. *pubescens* are once forked. The literature report for Accomack Co. (Harvill et al. 1992) is likely based on Reed (1960). But the specimens cited in Reed (1960) from Accomack Co. [1955: 36611, 36814, 36857, and 37071 (now at MO)] have forked veins and have been annotated as *Thelypteris palustris* var. *pubescens* (George Yatskievych, pers. comm., 2005).

***Thelypteris palustris* Schott var. *pubescens* (Lawson) Fern.**

Synonym(s): *Dryopteris thelypteris* (L.) Gray var. *pubescens* (Lawson) Weath.; *T. palustris* var. *haleana* Fern.

Common name(s): marsh fern

N.A. Distribution: Lab., Nfld., se. Que., Ont., Man., N. Dak., s. to Fla., w. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; open floodplains, wet meadows, fresh and brackish tidal marshes.

Comments: The veins of each sub-leaflet are once forked. The var. *palustris* is European.

***Phegopteris hexagonoptera* (Michx.) Fee**

Synonym(s): *Dryopteris hexagonoptera* (Michx.) C. Christensen; *Thelypteris hexagonoptera* (Michx.) Weatherby

Common name(s): broad beech fern

N.A. Distribution: se. Que. and Ont., Mich., s. to Fla., w. to e. Tex.

Delmarva Distribution: **Del.:** New Castle; Kent; Sussex. **Md.:** Cecil; Kent; Queen Anne's; Caroline; Talbot; Worcester. **Va.:** Accomack; Northampton.

Delmarva Status, Duration, and Habitat: Infrequent; deciduous; moist rich woods, ravines and slopes. Within the database of the Maryland Wildlife and Heritage Program (Maryland Dept. of Natural Resources), there exists a record for *Gymnocarpium dryopteris* (L.) Newman from Talbot Co. (Wes Knapp, pers. comm., 2002). This site has been searched by the author without success and the habitat does not appear to be suitable for the species (disturbed, early successional woodland on moist sandy-loam soils). *Gymnocarpium dryopteris* is a northern species, reaching its south-

ern limit in Pennsylvania and northern New Jersey. The record gives no indication that a collection was ever made and notes associated with this record state "all plants appeared in poor health." This species was likely misidentified and was probably a diminutive form of *P. hexagonoptera*, the only species on Delmarva that *G. dryopteris* could be confused with. Therefore, this record is not recognized and *G. dryopteris* is excluded from this checklist.

Family Blechnaceae - Deer Ferns

***Woodwardia areolata* (L.) T. Moore**

Synonym(s): *Lorinseria areolata* (L.) Presl

Common name(s): netted chainfern

N.A. Distribution: southern; mostly on the Coastal Plain, se. N.S., se. Maine, se. N.H., s. to Fla., w. to Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; acid wet woods and swamps.

Comments: Species is dimorphic and sterile plants can be confused with *Onoclea sensibilis*. The leaflets of *W. areolata* are alternate and the margins are serrate, whereas *Onoclea* has opposite leaflets and the margins are entire.

***Woodwardia virginica* (L.) Sm.**

Synonym(s): *Anchistea virginica* (L.) Presl

Common name(s): Virginia chainfern

N.A. Distribution: Mostly Coastal Plain, N.S., w. to Mich., se. to Fla., w. to Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Frequent; deciduous; acid swamps, peaty swales, and depressional wetlands.

Comments: This species is monomorphic (fertile and sterile fronds are all alike). Species is most frequent in the southern counties of Delmarva, becoming uncommon to rare farther north. The black stipe of this species is diagnostic.

Family Dryopteridaceae - Wood Ferns

***Onoclea sensibilis* L.**

Common name(s): sensitive fern

N.A. Distribution: Nfld., s. Que. to se. Man., Maine, s. to Fla., e. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous (sterile fronds); open swamps, floodplains, marshes, wet meadows, mesic woods, and ditches.

Comments: Species is dimorphic and the fertile fronds (produced late in the season) are persistent through the winter, while the vegetative (sterile) fronds are deciduous.

***Diplazium pycnocarpon* (Spreng.) Broun**

Synonym(s): *Athyrium pycnocarpon* (Spreng.) Broun

Common name(s): glade fern

N.A. Distribution: s. Que. and Ont., se. Mich., N.H., Vt., s. to n. Fla., w. to Miss.

Delmarva Distribution: Md.: Cecil.

Delmarva Status, Duration, and Habitat: Rare; deciduous; moist, shady wooded ravine with rich organic soils.

Comments: This species, known from a single extant occurrence on Delmarva, was a new addition to the flora when first discovered by botanists Jack Holt and Janet Ebert in 2002. This species is similar to Christmas fern (*Polystichum acrostichoides*), but is not evergreen and the leaflets lack auricles.

***Deparia acrostichoides* (Sw.) M. Kato**

Synonym(s): *Athyrium acrostichoides* (Sw.) Diels; *A. thelypteroides* (Michx.) Desv.

Common name(s): silvery spleenwort

N.A. Distribution: northern; N.S., s. Que. and Ont., s. to w. S.C., n. Ga., n. Ala., ne. Ark.

Delmarva Distribution: Del.: New Castle; Sussex. **Md.:** Cecil; Kent; Talbot, HIST. (*E. Earle* 2489, 1940, PH). **Va.:** Accomack.

Delmarva Status, Duration, and Habitat: Rare; deciduous; deciduous woods and slopes with moist, rich organic soils.

Comments: This species is rare for the Coastal Plain province. On Delmarva, the majority of the extant occurrences are from the northern counties of the Peninsula. Both Reed (1953) and Redman (1991) cite Worcester as a county of occurrence for this species, likely based on Beaven & Oosting's (1939) listing of the species from the Pocomoke Swamp. A specimen at DUKE collected by Beaven from the Pocomoke Swamp in Worcester Co., was labeled *Athyrium acrostichoides*, but was misidentified and has been annotated as *Athyrium filix-femina* var. *asplenoides* (Robert Wilbur, pers. comm., 1999).

***Athyrium filix-femina* (L.) Mertens var. *angustum* (Willd.) Lawson**

Synonym(s): *A. angustum* (Willd.) Presl; *A. filix-femina* var. *michauxii* (Spreng.) Farw.

Common name(s): northern lady fern

N.A. Distribution: northern; Nfld., w. to Sask., Maine s. to N.C., w. to Mo.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; moist woods, floodplains, swamps.

Comments: Within populations of the northern lady fern, a red-stemmed form is often present, designated as forma *rubellum* (Gilbert) Farw. The type variety, *filix-femina* is native to Europe. FNA (1993) recognizes four

North American taxa, the two listed here, which are eastern and two western varieties: *cyclosorum* Ruprecht and *californicum* Butters.

***Athyrium filix-femina* (L.) Mertens var. *asplenioides* (Michx.) Farw.**

Synonym(s): *A. asplenioides* (Michx.) Des.

Common name(s): southern lady fern

N.A. Distribution: southern; Mass., R.I., Conn., s. to n. Fla., w. to e. Texas, e. Kans.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; deciduous; moist woods, floodplains, swamps.

Comments: On Delmarva, both the northern and southern lady fern are frequent in all counties and tend to intergrade, thus making separation difficult at times. The fronds of var. *angustum* narrow to the base, with the longest leaflet near, or just below the middle. The blades of var. *asplenioides* are slightly narrowed to the base, with the lowest leaflet being the longest. Based on spore morphology and genetic differentiation, Kelloff et al. (2002) gives evidence to support distinction of the *Athyrium* taxa *angustum* and *asplenioides* at the rank of either subspecies or species.

***Cystopteris protrusa* (Weath.) Blasdell**

Synonym(s): *C. fragilis* (L.) Bernh. var. *protrusa* Weath.

Common name(s): lowland fragile fern

N.A. Distribution: Conn., w. to Minn., s. through the mountains and Piedmont to n. N.J., sw. to n. La.

Delmarva Distribution: Del.: New Castle, HIST. (*J. Ebert & R. Holt*, 1993).

Delmarva Status, Duration, and Habitat: Rare; deciduous; rich alluvial floodplains.

Comments: This species is distributed primarily within the Mountain and Piedmont provinces of the eastern U.S. The species occurrence on the Coastal Plain of Delmarva is quite rare, but unfortunately, the only known population in New Castle Co. may have been destroyed through construction activities. This population was reported, but not vouchered by two very credible botanists, Janet Ebert and Jack Holt in 1993. Their report included detailed location, habitat and population data. This population occurred on the inner Coastal Plain, about one mile (1.6 km) south of the fall-line. Habitat is a rich alluvial floodplain of a creek that originates in the Piedmont province of Delaware, where several populations of *C. protrusa* are known to exist.

Woodsia obtusa* (Spreng.) Torr. subsp. *obtusa

Common name(s): blunt-lobe woodsia

N.A. Distribution: se. Que. and Ont., Wis., s. Maine, s. to w. Fla. (avoiding the outer Coastal Plain), w. to e. Tex., Okla., Nebr.

Delmarva Distribution: Del.: Kent. Md.: Queen Anne's; Talbot.

Delmarva Status, Duration, and Habitat: Rare; evergreen (sterile fronds); rich wooded slopes.

Comments: Species is a rare Coastal Plain occurrence throughout its range and is rarely terrestrial. It typically grows on rock substrates that are often calcareous. *Woodsia obtusa* subsp. *occidentalis* Windham occurs at the western edge of the species range.

***Dryopteris marginalis* (L.) Gray**

Common name(s): marginal wood fern

N.A. Distribution: northern; Nfld., se. Que., Wis., s. to w. Va., n. Ga., n. Ala., w. to e. Okla.

Delmarva Distribution: **Del.:** New Castle; Kent; Sussex. **Md.:** Cecil; Kent; Queen Anne's; Caroline; Talbot; Dorchester, LIT. (Reed 1953, *nss*); Wicomico, HIST. (R. Tatnall 4567, 1940, DOV); Somerset, LIT. (Reed 1953, *nss*); Worcester, LIT. (Reed 1953, *nss*).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; moist woods and steep slopes, usually with rich organic soils and often with *Polystichum acrostichoides*.

Comments: More frequent in the northern counties of Delmarva on steep slopes, rare farther south. The sori of this species are positioned near the margins of the leaflets.

***Dryopteris goldiana* (Hook. ex Goldie) Gray**

Common name(s): Goldie's wood fern

N.A. Distribution: northern; N.B., se. Que., Minn., New England, south in the mountains to Ga.

Delmarva Distribution: **Del.:** New Castle.

Delmarva Status, Duration, and Habitat: Rare; deciduous; moist woods with rich organic soils.

Comments: This species just makes it onto the Coastal Plain of Delmarva and is known from a single extant population about .5 miles (2.8 km.) south of the fall-line in New Castle County.

***Dryopteris celsa* (Wm. Palmer) Knowlt., Palmer & Pollard ex Small**

Synonym(s): *D. goldiana* (Hook. ex Goldie) A. Gray subsp. *celsa* W. Palmer; *D. xcelsa* (Palmer) Small, *D. goldiana* x *clintoniana* (Tatnall 1946); *D. xclintoniana* Wherry forma *celsa* (Palmer) Wherry, *D. goldiana* x *cristata* (Reed 1953)

Common name(s): log wood fern

N.A. Distribution: se. Pa., ne. N.J. south to S.C., west to Ark. and n. La., disjunct in N.Y. and Mich.

Delmarva Distribution: **Del.:** New Castle; Kent. **Md.:** Cecil, LIT. (Redman 1991, *nss*); Queen Anne's; Caroline; Talbot; Wicomico; Somerset; Worcester.

Delmarva Status, Duration, and Habitat: Infrequent; rich seepage swamps and floodplains.

Comments: The only report of this species from Cecil Co. is based on Redman (1991) who gives no indication if the report is from the Delmarva region of the county. I have seen specimens at PH of this species from the Piedmont and Western Shore of Cecil Co. and have personally collected it from Cecil Co.'s Western Shore (*McAvoy* 2465, 1997, DOV).

***Dryopteris clintoniana* (D.C. Eaton) Dowell**

Synonym(s): *D. cristata* (L.) A. Gray var. *clintoniana* (D.C. Eaton) L. Underw.; *D. xclintoniana* (D.C. Eaton) Wherry, *D. goldiana* x *cristata* (Reed 1953).

Common name(s): Clinton's wood fern

N.A. Distribution: northern; N.B., se. Que., se. Ont., s. to central Pa. and n. N.J, w. to Mich., n. Ind.,

Delmarva Distribution: **Del.:** New Castle; Sussex. **Md.:** Queen Anne's; Somerset.

Delmarva Status, Duration, and Habitat: Rare; evergreen; rich seepage swamps.

Comments: Based on the literature (Carlson & Wagner 1982; Montgomery & Fairbrothers 1992; Rhoads & Klein 1993), this species appears to be rare south of the Wisconsin glacial line, and Delmarva populations apparently mark the southern extreme for the species (James Montgomery, pers. comm., 2005). First documented on Delmarva from Sussex Co. (*McAvoy* 1549, 1996, DOV) and confirmed by James Montgomery, a noted *Dryopteris* specialist, and by Bill Olson a highly respected botanist from Pennsylvania. A specimen labeled *D. celsa* from Wicomico Co., Maryland (*Smith s.n.*, 1949, PH) has been examined by James Montgomery that "may possibly" be *D. clintoniana* (J. Montgomery, pers. comm., 2000), but the specimen is such that a definitive determination can not be made. In addition, E. Wherry (no date) annotated this specimen with the following notation: "locality subsequently destroyed." This species can be confused with *D. celsa*, but the lowest leaflets of *D. clintoniana* are triangular (broadest at the base), while the lowest leaflets of *D. celsa* are ovate (broadest above the base). In addition, the fertile fronds of *D. clintoniana* are lanceolate with parallel sides, while the fertile fronds of *D. celsa* are ovate-lanceolate and gradually narrowed to the tip.

***Dryopteris cristata* (L.) Gray**

Common name(s): crested wood fern

N.A. Distribution: northern; Nfld., s. Man., se. B.C., s. to N.C.

Delmarva Distribution: **Del.:** New Castle; Kent; Sussex. **Md.:** Cecil; Kent; Queen Anne's; Caroline; Talbot; Dorchester; Wicomico; Worcester. **Va.:** Accomack.

Delmarva Status, Duration, and Habitat: Frequent; evergreen; seepage swamps and floodplains.

Comments: The lower leaflets of the fertile fronds will twist horizontally.

***Dryopteris intermedia* (Muhl. ex Willd.) Gray**

Synonym(s): *D. spinulosa* (O.F. Muell.) Watt var. *intermedia* (Muhl. ex Willd.) Underw.

Common name(s): evergreen wood fern

N.A. Distribution: northern; Nfld., w. to Ont., Minn., s. to se. Va., and s. in the mountains to n. Ga.

Delmarva Distribution: All Counties, except Northampton.

Delmarva Status, Duration, and Habitat: Frequent; evergreen; moist woods, swamps and floodplains.

Comments: Similar to *D. carthusiana*, but *D. intermedia* has hat pin-like glandular hairs on the indusia and rachis. Rare in Accomack County.

***Dryopteris carthusiana* (Vill.) H.P. Fuchs**

Synonym(s): *D. spinulosa* (O.F. Muell.) Watt

Common name(s): spinulose wood fern

N.A. Distribution: N.S. w. to B.C., Nebr., Maine, s. to S.C.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Frequent; deciduous; moist woods, slopes, swamps, floodplains, stream banks.

Comments: *Dryopteris carthusiana* is often confused with *D. intermedia*, but *D. intermedia* is evergreen and has glandular hairs on the indusia and rachis.

Dryopteris celsa* x *cristata

Common name(s): hybrid wood fern

Delmarva Distribution: Del.: New Castle; Kent. Md.: Talbot.

Delmarva Status, Duration, and Habitat: Rare; evergreen; seepage swamps and floodplains.

Comments: The genus *Dryopteris* is quite promiscuous with four hybrids reported from Delmarva. Hybrids can be recognized by their intermediate morphology and if spores are produced, they are irregular in size, shape and color.

***Dryopteris xboottii* (Tuck.) Underw.**

Synonym(s): *D. cristata* x *intermedia*

Common name(s): hybrid wood fern

N.A. Distribution: Nfld. to Wis., s. to Pa., N.J., W.Va., and Tenn.

Delmarva Distribution: Md.: Wicomico, HIST. (*Smith s.n.*, 1950, PH).

Delmarva Status, Duration, and Habitat: Rare; evergreen; floodplain swamps.

***Dryopteris xslossonae* Wherry**

Synonym(s): *D. cristata* x *marginalis*

Common name(s): hybrid wood fern

N.A. Distribution: N.B., Wis., Maine, s. to Va.

Delmarva Distribution: Del.: Kent, HIST. (*D. Redman 2814*, 1974, BALT). Md.: Talbot, LIT. (Reed 1953, *nss*).

Delmarva Status, Duration, and Habitat: Rare; sub-evergreen; swampy floodplains.

***Dryopteris xtriploidea* Wherry**

Synonym(s): *D. carthusiana* x *intermedia*

Common name(s): hybrid wood fern

N.A. Distribution: N.S., w. to Minn., s. to Ky. and N.C.

Delmarva Distribution: Del.: New Castle; Sussex. Md.: Queen Anne's.

Delmarva Status, Duration, and Habitat: Status uncertain; sub-evergreen; moist woods, swamps and floodplains.

Comments: This hybrid wood fern has the appearance of *D. carthusiana* and the glandular hairs of *D. intermedia*. This hybrid is likely more frequent than current data indicates.

***Polystichum acrostichoides* (Michx.) Schott**

Common name(s): Christmas fern

N.A. Distribution: N.S., se. Que. and Ont., Wis., s. to Fla., w. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Frequent; evergreen; deciduous and evergreen woodlands with moist soils (usually rich organic soils), eroding slopes of ravines and stream banks.

Comments: Species is dimorphic, the fertile leaflets are in the upper portion of the blade and are much smaller than the vegetative leaflets below. Leaflets can be variable in shape and many forms have been described. This species is a good indicator of Coastal Plain rich wood habitat.

Family Polypodiaceae - Polypodys

***Polypodium virginianum* L.**

Synonym(s): *P. vulgare* var. *virginianum* (L.) D.C. Eaton

Common name(s): common polypody

N.A. Distribution: Lab., Nfld., w. to ne. Alta., Minn., s. to w. S.C., Tenn., Ark.

Delmarva Distribution: Del.: New Castle; Sussex. Md.: Cecil; Kent; Queen Anne's, LIT. (Redman 1991, *nss*); Caroline; Talbot; Dorchester (*R. Wilson 0825992*, 1991, pers. coll.); Wicomico, HIST. (*E. Wherry s.n.*, 1936, PH).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; primarily on bare soil and base of trees on steep slopes above rivers and creeks, rarely in flat woods at base of trees.

Comments: Most frequently encountered in the Maryland counties of Cecil, Kent, Caroline, and Talbot on steep slopes above tidal rivers; rare farther south.

Pleopeltis polypodioides (L.) Andrews & Windham subsp. *michauxiana* (Weath.) Andrews & Windham

Synonym(s): *Polypodium polypodioides* (L.) Watt var. *michauxianum* Weath.

Common name(s): resurrection fern

N.A. Distribution: southern; Del., Md., W. Va., s. to Fla., w. to e. Tex., n. to Okla.

Delmarva Distribution: **Del.:** Sussex, HIST. (*A. Commons s.n.*, 1874, PH). **Md.:** Wicomico; Worcester. **Va.:** Accomack, HIST. (*C. Reed 39650*, 1955, MO); Northampton, HIST. (*W. Palmer s.n.*, 1895, US; Palmer 1899).

Delmarva Status, Duration, and Habitat: Rare; evergreen; epiphytic on tree trunks and branches in swamps and floodplains.

Comments: The stronghold for this species on the Peninsula is within the Pocomoke River drainage of Wicomico and Worcester Counties (specifically on Nassawango Creek and along the Pocomoke River). It is within this region of Delmarva where the only extant populations for the species are to be found. A literature report (Hadaway 1992) lists this species from Kent Co. (Md.), but this specimen was misidentified and has been annotated as *P. virginianum* (Eric Hadaway, pers. comm., 1998). Curiously, the historical population from Accomack Co. was actually last observed (not collected) in the late 1980's - early 1990's by Frank Hirst and Ron Wilson (F. Hirst & R. Wilson, pers. comm., 1995). They report that the limbs that the species were growing on (a giant *Liriodendron tulipifera*) were "loaded" with plants, but on annual visits (since 1995) to this site, the author has not found a single frond, it has simply vanished.

Gymnosperms

Division Pinophyta – Hemlock, Pine, Cypress, Cedar

Order Pinales

Family Pinaceae - Pines

Tsuga canadensis (L.) Carr.

Synonym(s): *Pinus canadensis* L.

Common name(s): eastern hemlock

N.A. Distribution: northern; N.S., N.B., se. Que. and Ont., e. Minn., Maine, in the mountains s. to n. Ga.

Delmarva Distribution: **Del.:** New Castle. **Md.:** Cecil; Kent; Queen Anne's; Caroline; Talbot.

Delmarva Status, Duration, and Habitat: Infrequent to rare; evergreen; steep north and east facing slopes above tidal rivers.

Comments: This species is rare on the Coastal Plain of the eastern U.S. and occurrences on the Delmarva Peninsula represent relict, disjunct populations (McAvoy & McAvoy 2003). The hemlock woolly adelgid, an exotic insect pest threatens the existence of this species on Delmarva. Occasionally, this species is found planted around old home sites.

Pinus echinata P. Mill.

Common name(s): shortleaf pine

N.A. Distribution: southern; N.J., s. to n. Fla., w. to e. Tex., ne. to Mo.

Delmarva Distribution: **Del.:** Kent, LIT. (Taber 1960, *nss*); Sussex. **Md.:** Caroline; Wicomico; Worcester. **Va.:** Accomack; Northampton, LIT. (V.B.A. 2005, *nss*).

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; dry sandy soils, ancient sand dunes or ridges.

Comments: Rarely dominates the canopy, usually found with other pines and as lone individuals. This species is locally abundant in the counties of Caroline, Wicomico and Worcester. Evident resin pockets on the bark plates are a diagnostic field character.

***Pinus rigida* Miller**

Synonym(s): *P. rigida* P. Mill. subsp. *rigida*

Common name(s): pitch pine

N.A. Distribution: northern; se. Maine, s. to Ohio and Md., s. in the mountains to ne. Ga.

Delmarva Distribution: **Del.:** New Castle, HIST. (*B. Long* 57757, 1942, PH); Kent, LIT. (Taber 1960, *nss*); Sussex. **Md.:** Caroline; Wicomico; Worcester.

Delmarva Status, Duration, and Habitat: Infrequent; evergreen; dry to moist sandy soils and coastal dunes.

Comments: Large, but local populations are known from Sussex (Cape Henlopen) and Caroline Counties (Idylwild Wildlife Management Area). Outside of these areas, the species is found as small, scattered populations and as lone individuals.

***Pinus serotina* Michx.**

Synonym(s): *P. rigida* Miller subsp. *serotina* (Michx.) Clausen; *P. rigida* var. *serotina* (Michx.) Hoopes

Common name(s): pond pine

N.A. Distribution: southern; s. N.J., s. to n. Fla., w. to se. Ala.

Delmarva Distribution: **Del.:** Kent, LIT. (Taber 1960, *nss*); Sussex. **Md.:** Caroline; Dorchester; Wicomico; Worcester. **Va.:** Accomack, LIT. (Mazzeo 1972, *nss*); Northampton, LIT. (Mazzeo 1972, *nss*).

Delmarva Status, Duration, and Habitat: Infrequent to frequent; evergreen; swamps (often associated with Atlantic white cedar) and mesic soils on sandy slopes and flats.

Comments: *Pinus serotina* and *P. rigida* are closely related. *Pinus serotina* has been described as a distinct species, as well as a subspecies and variety of *P. rigida*. *Pinus serotina* is treated as distinct by Kral (FNA 1993), and he gives well defined geographic ranges for both *P. serotina* and *P. rigida*. *Pinus rigida* has a somewhat more northern distribution within the Mountain and Piedmont provinces, and *P. serotina* is more southern and chiefly Coastal Plain. Only on the Delmarva Peninsula and in southern New Jersey do the two meet; it is within this "contact zone," as described by Smuse and Saylor (1973), where the taxonomy of the two entities becomes compli-

cated. On Delmarva, the two can grow together and intermediates are often found containing the morphological characters of both. Hybrids between the two have been reported (Little et al. 1967; Smouse & Saylor 1973), and to further cloud the issue, *P. rigida* and *P. serotina* are also known to interbreed with *P. taeda* and *P. echinata* (Little et al. 1967; Smouse & Saylor 1973). In addition, the two taxa on Delmarva appear to overlap in relation to edaphic conditions; both will inhabit moist sandy soils. To distinguish the two in the broad sense: the cones of *P. rigida* are ovoid acute (longer than broad) with a round bottom, an elevated triangular umbo with stout prickles, and the needles are shorter (6-12 cm.) compared to *P. serotina*; the cones of *P. serotina* are sub-globose rounded (broader than long) with a flat bottom, a poorly defined umbo with weak prickles, and the needles are longer (13 to 21 cm.) compared to *P. rigida*. But again, intermediates are often found.

***Pinus strobus* L.**

Common name(s): Eastern white pine

N.A. Distribution: Nfld., s. Que. and Ont., Minn., Maine, in the mountains s. to n. Ga.

Comments: Not native to Delmarva, but this species has been widely planted in the landscape throughout the Peninsula and the author has observed this species as a rare escape to woodlands. Taber (1960) in his trees of Delaware, which was first published in 1939, reports that, "there remains only one known natural stand situated west of Harrington, in Kent County [Delaware]." Tatnall (1946) reports a "fine stand of mature white pine 3 miles southwest of Harrington, Kent Co. [Delaware]," but points out that a resident of the area told him that "these trees had been planted by his grandfather." Taber's quote is curious, because Tatnall (1946) cites a collection [(W.S. Taber), R.R. Tatnall, 2849, 27 Oct. 1935, personal collection], which indicates that Taber was with Tatnall at the time of the collection, so why Taber would make such a statement is odd.

***Pinus palustris* Miller**

Common name(s): longleaf pine

N.A. Distribution: se. Va., s. to Fla., w. to e. Tex.

Delmarva Distribution: Del.: Sussex. Md.: Caroline. Va.: Accomack, HIST. (*H. Moldenke* 2780, 1925, NY).

Comments: The nativity of longleaf pine on the Delmarva Peninsula has been debated. In addition to FNA (1993), Boyer (1990) gives the range of this species as reaching its northern extreme in southeast Virginia. *Pinus palustris* is extant on Delmarva only from planted, non-native populations: the species has been intentionally planted in a natural area in Sussex Co. [Angola Neck (Pete Martin, pers. comm., 2005 and Rob Line, pers. comm., 2005) and a natural area in Caroline Co. [Idylwild Wildlife Mgmt. Area (Wes Knapp, pers. comm., 2005 and staff of the Le Compte Wildlife Mgmt. Area, pers. comm., 2005)]. The Caroline Co. population appears to be of

mixed age and cones have been observed (Wes Knapp, pers. comm., 2005), so apparently, the species is reproducing on Delmarva. Historical records of red-cockaded woodpecker (RCW), which prefers longleaf pine for cavity nests, have been published for Delmarva (Robbins & Blom 1996). In the Blackwater region of Dorchester Co., RCW has been observed periodically from 1932 to 1976 (Robbins & Blom 1996), and a “young bird” was observed on Assateague Island, Worcester Co. (Robbins & Blom 1996) in 1939. Based on these records of RCW, some have argued that longleaf pine must have been present on Delmarva, but longleaf pine has never been reported from these areas. In addition, RCW is known to utilize other species of pine for cavity nests (Jackson 1994), such as loblolly pine (*P. taeda*), shortleaf pine, Virginia pine (*P. virginiana*) and pitch pine (Jackson 1994). Also, Jackson (1994) pointed out that nineteenth century records beyond the current range of RCW include northern New Jersey and southeast Pennsylvania, and that longleaf pine has never been reported this far north. Another piece of evidence that has been used to justify the occurrence of longleaf pine on Delmarva are place names, such as Girdle-tree (Worcester Co.) and Tar Bay (Accomack Co.), which suggests a pine tar industry once existed in the area. Longleaf pine is well known for its ability to produce high quantities of resin or tar, which was first exploited by early European settlers (Outcalt 2000) for a variety of uses, such as to seal cracks in sailing ships (Outcalt 2000). Loblolly pine, which is quite common and widespread in southern Delmarva (see description below), was also used as a source for pine tar by the early settlers (Lee 2006) for many of the same purposes as longleaf pine tar. If a pine tar industry did exist in southern Delmarva, and longleaf pine was the source of this tar, it then seems logical to assume that historical information about the specific use of longleaf pine in this industry should exist, yet the author is unaware of any. In the herbarium of the New York Botanical Garden (NY), a specimen labeled *P. palustris* exists that was collected by Harold Moldenke (1909-1996) in 1925 from Accomack Co. (Accomack Co., Va., “In sandy woods, Sinnickson, Longleaf pine,” 8 Dec. 1935, *H. Moldenke 2780*, NY). This specimen consists of two leaves (two fascicles each containing three leaves) up to 29 cm. long. I was fortunate enough to obtain a copy of notes related to Moldenke’s collection that were compiled by a noted ecologist from North Carolina (who will remain anonymous for this paper), who was studying longleaf pine. In these notes, the ecologist points out that he examined Moldenke’s collection at NY, and that he interviewed Moldenke in 1979 regarding his collection. In his notes, the ecologist states that “it was his [Moldenke] belief that this was a natural stand.” The ecologist goes on to say that he visited the site himself, “along the road from Silva [now known as Signpost] to Sinnickson” in 1979, but could not relocate the population. The ecologist also points out in his notes that Moldenke collected a specimen of *P. palustris* from the same site in 1911 [specimen not at NY, (Thomas Zanoni, pers. comm., 2005)]. The ecologist examined this specimen and states that it had been annotated as “cultivated speci-

men,” by “someone who apparently disbelieved that natural longleaf occurred that far north.” These notes are curious because Moldenke was born in 1909 and he would have been two years old when making a collection in 1911. Perhaps the ecologist mistakenly typed 1911 for Moldenke’s collection date when he should have typed 1925, but he typed 1911 twice in the same paragraph and also used 1911 again in subsequent pages of related notes. I’ll also add that Moldenke was 16 years of age when he made the 1925 collection and he had already accumulated 2780 specimen numbers (Thomas Zanoni, pers. comm., 2005). I am familiar with, and have done field work in the area where Moldenke made his collection in Accomack Co., but have never found native or planted populations of this species. I would not expect to find native populations of longleaf pine in this area, but an obvious plantation of this species would not be a surprise. In addition, Clyde Reed and Frank Hirst, who are both cited many times in this paper, have also done field work in this area in the past (see Reed 1956 and 1960 for text specific to this area) and both have never reported finding this species. In a conversation with Virginia botanist Tom Wieboldt, Tom points out that *P. palustris* tends to “shun the outer Coastal Plain from central NC northward” (Tom Wieboldt, pers. comm., 2006). The southern portion of Delmarva where native longleaf pine is alleged to have once existed falls within the outer Coastal Plain region. Finally, none of the local floras (Brown & Brown 1972; Weakley 2006), or checklists (Tatnall 1946; Mazzeo 1972; Harvill et al. 1992; V.B.A. 2005) of the region give any indication that *P. palustris* ever existed on the Delmarva Peninsula. Until further research proves otherwise, this study does not consider longleaf pine to be native in Accomack Co., nor on the Delmarva Peninsula.

***Pinus taeda* L.**

Common name(s): loblolly pine

N.A. Distribution: southern; s. N.J., s. to n. Fla., w. to e. Tex.

Delmarva Distribution: All Counties, except Cecil.

Delmarva Status, Duration, and Habitat: Common; evergreen; poorly-drained to well-drained soils.

Comments: Most common from central Delmarva south. Often dominates the canopy, or appears as a co-dominant. Native populations in New Castle Co. are restricted to a narrow zone near the Delaware Bay. *Pinus taeda* is a commercially important species that forms the foundation for 1000’s of acres of plantations on Delmarva. Pre-settlement, this species was likely confined to the swamps of southern Delmarva, but with colonization and land-clearing, it has now become widely and well established on a variety of soil types.

***Pinus thunbergiana* Franco**

Common name(s): Japanese black pine

Delmarva Distribution: Del.: Sussex. Md.: Worcester.

Comments: Native of Japan and Asia. The species was planted to stabilize dunes along Delmarva's Atlantic coast in Sussex (Tony Pratt, pers. comm.) and Worcester Counties [Assateague State Park, (Angela Baldwin, pers. comm., 2005)]. This species is well established and widespread on dunes in Sussex Co. and is reproducing. This species is also reported from Mass., N.Y., N.J., Va. and N.C (Nature Serve Explorer 2005). Many dead and dying individuals of this species have been observed by the author along the Atlantic coast of Sussex County. The pinewood nematode (*Bursaphelenchus xylophilus*) has been identified as the species that is causing the trauma (Rob Line, pers. comm., 2006).

***Pinus virginiana* Miller**

Common name(s): Virginia pine

N.A. Distribution: southern; L.I., N.Y., w. to Ohio, s. to n. Ga. and Miss.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; evergreen; well-drained soils, young woodlands, edges, old fields.

Comments: Early colonizer of disturbed sites and abandoned fields. Pre-settlement, this pine was likely most abundant in the Piedmont and at low elevations in the Mountains, but with colonization and land clearing, it is now well established and wide spread on the Coastal Plain in the northern part of its range.

Family Cupressaceae - Cypresses

***Taxodium distichum* (L.) L.C. Richard**

Synonym(s): *T. distichum* (L.) L.C. Richard var. *distichum*

Common name(s): bald cypress

N.A. Distribution: southern; chiefly Coastal Plain, Del., s. to Fla., w. to e. Tex., ne. to s. Ill. and Ind.

Delmarva Distribution: Del.: Kent; Sussex. Md.: Wicomico; Somerset; Worcester. Va.: Accomack.

Delmarva Status, Duration, and Habitat: Infrequent to frequent; deciduous; typically associated with fresh water non-tidal creeks and rivers on swampy floodplains, infrequently in tidal systems and in isolated stands away from water courses.

Comments: This species is at its extreme northern limit on Delmarva (Kent Co., Del.). Populations in Indiana are slightly more southern than populations on the Peninsula (Michael Homoya, pers. comm., 2003). Most frequent in the Pocomoke and Nanticoke watersheds of Sussex, Wicomico, Somerset and Worcester Counties.

***Chamaecyparis thyoides* (L.) B.S.P.**

Common name(s): Atlantic white cedar

N.A. Distribution: Mostly Coastal Plain, se. Maine, s. to n. Fla., w. to s. Miss.

Delmarva Distribution: **Del.:** New Castle, EXT. (*A. Commons s.n.*, 1867, PH); Kent; Sussex. **Md.:** Dorchester; Wicomico; Worcester. **Va.:** Accomack.

Delmarva Status, Duration, and Habitat: Infrequent to frequent; evergreen; fresh water non-tidal and tidal creeks and rivers on swampy floodplains; often in pure stands, rarely found as isolated stands in lowland swamps away from water courses.

Comments: Populations of this species are most frequently found in Sussex County, where they often occupy large areas of stream corridor. The only known New Castle Co. population of the species was destroyed when a storm in 1878 breached a barrier island that protected a freshwater swamp where *C. thyoides* was known to occur (Fleming 1978). The barrier island kept saltwater from the Delaware Bay out of the freshwater swamp, but the breach allowed saltwater to intrude, which then led to the species demise in this county. Known from just a single occurrence in Kent Co. (Del.) where it is barely holding on due to salt water intrusion. Mazzeo (1972) lists this species from Northampton Co., but points out that it has been “reported but not documented.” Therefore, *C. thyoides* is not recognized from this county on Delmarva.

Juniperus virginiana* L. var. *virginiana

Common name(s): red cedar

N.A. Distribution: se. Que. and Ont., se. N. Dak., Minn., s. Maine, s. to nw. Fla., w. to e. Tex.

Delmarva Distribution: All Counties.

Delmarva Status, Duration, and Habitat: Common; evergreen; old fields, edges, hedgerows, thickets, and early successional shrublands and woodlands.

Comments: The var. *silicicola* (Small) E. Murray is restricted to coastal foredunes from North Carolina to Florida.

***Picea rubens* Sargent**

Common name(s): red spruce

N.A. Distribution: northern; N.B., N.S., Ont., Que., s. through New England, N.Y., n. N.J., Pa., and s. at high elevations to N.C.

Comments: This species is primarily a northern Mountain species and is also found at high elevations in the south. This species is not native to the Coastal Plain of Delmarva, but it has been observed by the author around old-home sites and as an intentional planting to natural areas on private lands. Reproduction of this species is probably not taking place.

***Taxodium ascendens* Brongniart**

Synonym(s): *Cupressus disticha* L. var. *imbricaria* Nutt.; *T. distichum* (L.) L.C. Rich. var. *imbricarium* (Nutt.) Croom

Common name(s): pond cypress

N.A. Distribution: southern; strictly Coastal Plain, N.C., s. to Fla., w. to se. La.

Comments: Pond cypress is not native to Delmarva, but has been intentionally planted (Pete Martin, pers. comm.) at a natural area in south central Sussex County (Great Cypress Swamp Conservation Area). However, no reproduction of this species has been observed.

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NATURAL HISTORY NOTES

**Construction of Aestivation Cells by the Introduced European Slug,
Arion subfuscus, in Montgomery County, Maryland**

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Arion subfuscus (Drap.) is an abundant slug throughout central Maryland. It is frequently found under logs, bark, boards and other ground litter, or crawling about during damp or wet periods. The pronounced summer droughts of 2001 and 2002 provided the opportunity to observe numerous *A. subfuscus* in periods of drought stress. During those times, individuals of the genus *Arion* were common, but typically inactive beneath cover during daylight hours. On 11 July 2002 I observed several *Arion subfuscus* beneath a board, resting within clay “cells.” Such behavior has been described and illustrated by Falkner (1990) for *A. intermedius* (Normand) in Europe, but does not appear to have been reported for *Arion subfuscus*. Nor does it seem to have been reported for any species of *Arion* introduced in North America.

The slugs were observed under boards lying along the edge of a mowed grass field at the McKee Besheres Wildlife Management Area in Montgomery County, Maryland. The WMA is a 797.6 ha property managed by the Maryland Department of Natural Resources. It offers a mosaic of habitat types on level to gently sloping alluvial soil adjacent to the Potomac River. *Arion subfuscus* is abundant throughout the area, and on 11 July 2002 was virtually the only terrestrial mollusk observed. While most slugs were simply lying beneath cover, lifting a single board revealed three individuals within oval clay cells, and one empty cell (Fig. 1). The cells were clearly constructed by the slugs. The three slugs (cells A-C) were on their side, bent in half, with the foot against the clay wall and the anterior portion of the back in contact with the posterior portion of the back (Fig. 2). The empty cell (D) exhibited an opening (upper right corner of Fig. 1) where a slug had apparently exited. Although the cells were open at the top, I believe the board sealed them, and the openings were created when the board was removed. Cell B exhibited pieces of the top wall that had fallen, but remained approximately in place atop the enclosed *A. subfuscus* (Fig. 1).

Cells constructed by *A. subfuscus* differed in several ways from those constructed by *A. intermedius* and illustrated by Falkner (1990). Cells constructed by *A. intermedius* were smaller, and the enclosed slugs were not bent in half. In addition, the cell surface was rougher in texture. These differences are probably due to variation in substrata (soil vs. fine clay), and the size of the slugs. *Arion subfuscus*, being more than twice the length and bulk of *A. intermedius*, would save significant work by bending itself to reduce the size of the capsule to be constructed, while the smaller *A. intermedius* were able to lay full length within their smaller cells. Although *A. intermedius* was also abundant at the McKee Besheres WMA, none were observed to have constructed cells.

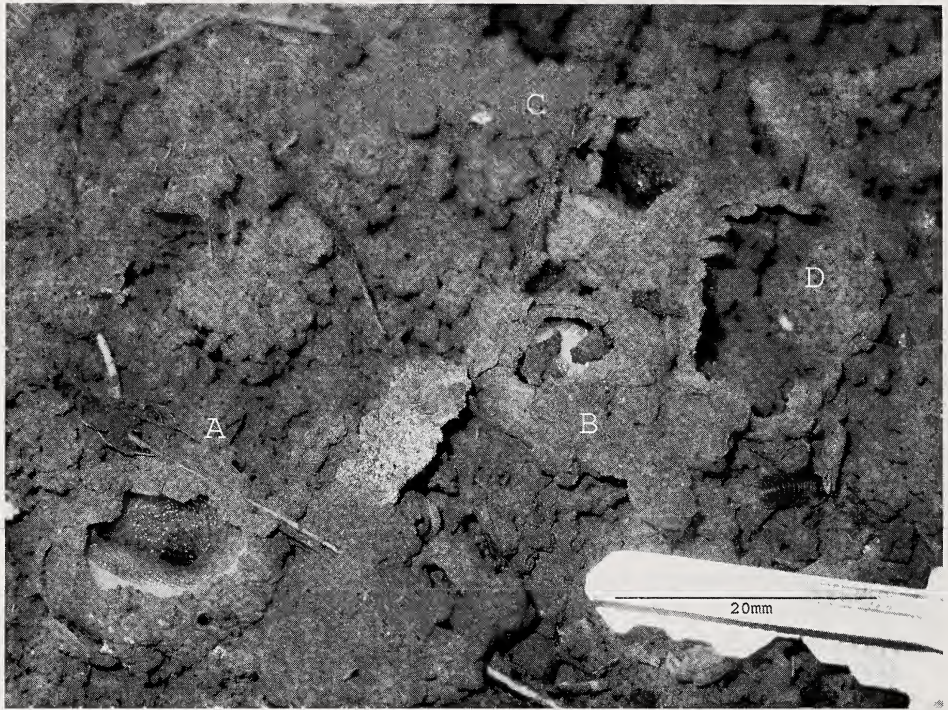


Figure 1. Aestivation cells constructed by *A. subfuscus* at McKee Beshers Wildlife Management Area, Montgomery County, Maryland. Three cells (A, B and C) contain slugs. Cell D has been vacated. Digital image by Peter Jayne.

Falkner (1990) stated that *A. intermedius* constructed their “earth nests” in dry forests by bringing together carefully sorted soil particles and cementing them together with mucous. It’s difficult to imagine how the cells of *A. subfuscus* were constructed. Since the thin walls were contoured to fit the shape of the animal’s body, they must have been built up from the inside. The bottom of the empty cell D was slightly depressed below the level of the surrounding soil, but the surface was not smooth as would be expected if the slug had scraped up enough soil to construct the walls and top (Fig. 1).

Although the purpose of these cells is not fully understood, by separating the slug from circulating dry air they would serve to reduce moisture loss, possibly reducing mortality due to desiccation during prolonged drought. They may also serve to reduce predation and parasitism during aestivation.

ACKNOWLEDGEMENTS

I would like to thank Peter Jayne, of the Maryland Forest, Wildlife and Heritage Administration, who made the digital image reproduced in Figure 1. Ken D’Loughy, the Regional Wildlife Manager, arranged access to the property. Lyle Chichester shared his extensive knowledge of slugs in North America. Henk Mienis referred me to Falkner’s book, and Suzanne Batra kindly translated the pertinent passages. John Norden prepared the images in Figures 1 and 2.

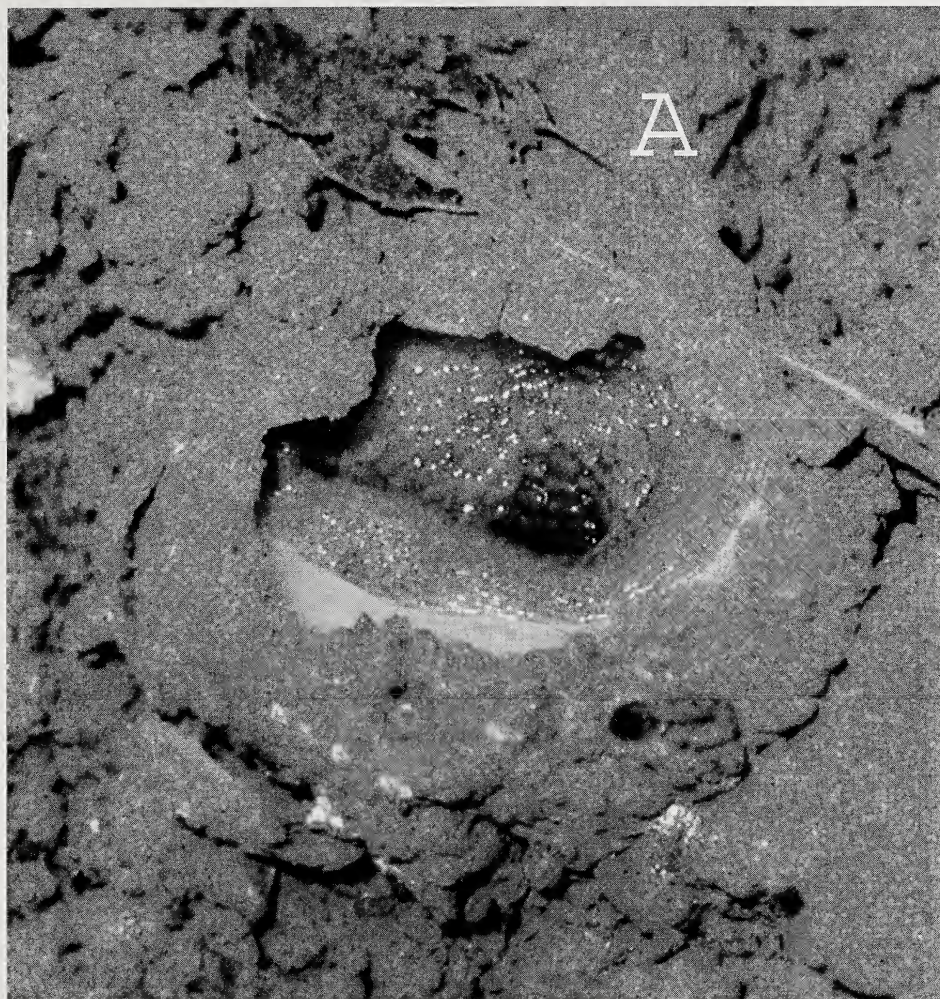


Figure 2. Detail of cell A showing enclosed *A. subfuscus*. Note the pale foot of the slug in contact with the thin, curved wall.

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NATURAL HISTORY NOTES

**Life History and Ecology of the Land Snail *Gastrocopta corticaria* (Say)
at Plummerville Island, Montgomery County, Maryland**

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Although *Gastrocopta corticaria* has been shown to occur widely throughout the eastern half of North America (Hubricht 1985), little concerning its ecology and life history has been reported. While conducting a survey of the land snails of Plummerville Island, the opportunity arose to make basic observations on certain aspects of the biology of this small land snail. Plummerville Island sits in the Potomac River near Cabin John, approximately 14.5 km upstream of central Washington, D.C.

When collection information has been reported for this species, it was typically described as uncommon and occurring on or under fallen branches and bark or other ground litter (Baker 1902, Leonard 1959, Brooks and Kutchka 1938), or, most frequently, on standing trees, specifically within one or two feet of the base (Baker 1939, Burch 1962, Pilsbury 1924, 1948, Say 1816). In fact, the only authority to suggest otherwise was Leonard (1959) who reported it from ground litter and the bark of trees, then specified that snails were also found "on the bark of living trees some distance above the ground." Although not stated in his description, Say (1816) undoubtedly chose to name this snail *corticaria* to reflect the frequency with which it was found on tree bark. When I first encountered *G. corticaria* at Plummerville Island, it was found in exactly the situations described in the literature, and I came to the conclusion that this was an uncommon snail found on the bases of trees and the adjacent ground. However, during the summer of 1995 a mature black walnut (*Juglans nigra* L.) fell across a trail within the study area. When I examined the trunk overhanging the path a colony of *G. corticaria* was found occupying a portion of the tree near the canopy. The surrounding forest was mature woodland characterized by a variety of oaks (*Quercus* spp.) and hickories (*Carya* spp.), on a sloping hillside where the floodplain of the Potomac River graded into an upland terrace.

The snails were most abundant where patches of bryophytes and hepatics (*Brachythecium acuminatum* [Hedw.] Aust., *Callicladium haldaniamum* [Grev.] Crum, *Frullania eboracensis* Gott) covered the trunk, and became less numerous where the moss thinned. *Gastrocopta* were seldom found on parts of the tree lacking bryoflora. The colony was centered at a point that would have been 13.4 meters (44 feet) above the ground when the tree was standing and extended vertically for about 1.2 meters up the trunk. The trunk where the snails were noted was 2.8 m in circumference, and since the colony extended over about half its circumference, it occupied an area of about 1.7 square meters.

Gastrocopta corticaria were observed on this tree on numerous occasions from early 1995 through the summer of 2000, when most of the bark had sloughed from the trunk and snails were no longer present. Although generally found on most visits, they

were most active during and after periods of rain. Then, numerous *G. corticaria* could be observed crawling on the bark. In winter and during dry periods of summer they were inactive and secreted in crevices. At those times they were very difficult to detect because their shells were coated with fine detritus of the same texture and color as the bark. That coating was notably sticky to the touch. In fact, I frequently picked up snails by simply touching them with the tip of a brush or grass blade, where they adhered so tightly that it was sometimes difficult to shake them off into a collecting container.

The density of snails varied, but they were numerous in places. Two population samples were taken, one on 20 May 1995 and the other on 3 June 1995. Those samples were acquired by collecting all snails within a randomly positioned 400 cm² wire frame. The frame was tacked to the bark, and all snails observed within it were removed and placed in 90% ethyl alcohol. Collecting was done over a ten-minute period. Those samples included 63 and 23 individuals. Since some snails within the quadrat area may have been inactive or remained out of sight during the collection period, the density of *G. corticaria* at those sites was probably greater than the number collected.

The snails were measured under low magnification with a digital micrometer accurate to 0.01 mm. The population was composed of individuals varying from slightly less than 1 mm to 2.8 mm, with most (53.2 %) measuring 2.3 mm or longer (Fig. 1). The larger individuals from Plummers Island were slightly longer than the maximum length of 2.5 mm given in the previously cited publications. However,

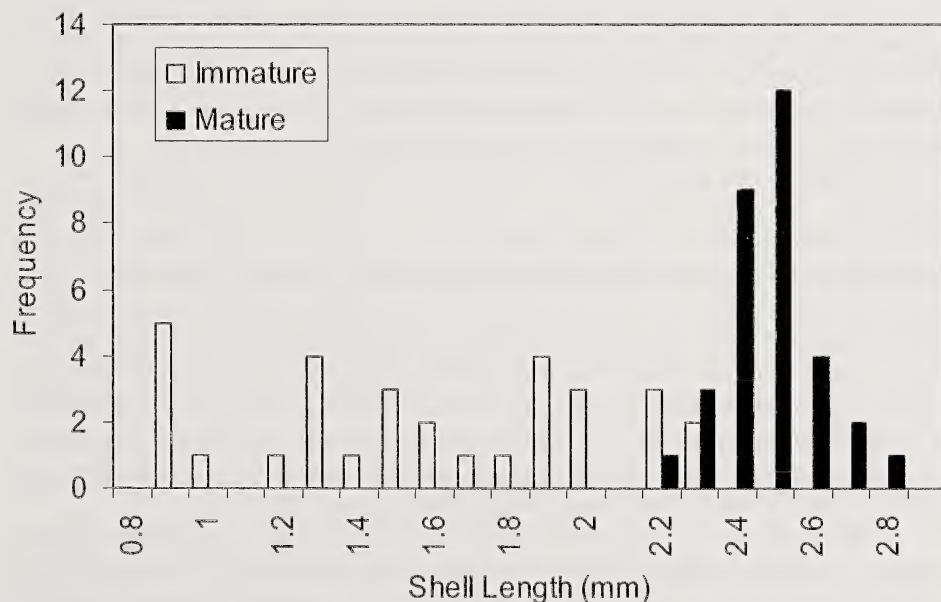


Figure 1. Shell length and presence of secondary sexual characteristics of *G. corticaria* from population sample collected on 20 May 1999 ($n = 63$). Hollow bars represent individuals without secondary sexual characteristics. Solid bars represent those with flared lip, angular or parietal lamellae.

Franzen and Leonard (1947) also reported that *G. corticaria* reached a shell length of 2.8 mm in Kansas.

I found nothing in the literature regarding reproduction in *G. corticaria*. During my period of observation no instances of mating or egg laying were noted, and eggs were never found. However, hatching appeared to be synchronized, with numerous hatchlings appearing in the first half of August in 1997, 1998 and 1999. A typical hatchling selected at random from a small series collected on 16 August 1996 measured 0.62 mm in diameter and 0.35 mm in height. Their appearance was so abrupt, and their size so similar that I am confident that the clutches of numerous females all hatched within a few days or weeks of each other. Snails in that size range were never observed at other times of the year. Considering this, I believe that mating and egg laying were also synchronized.

Adult *G. corticaria* have a flared lip around the aperture of the shell, and usually tooth-like columnar and parietal lamellae inside the aperture. Most adults exhibit a single columellar lamella and closely grouped parietal and angular lamellae that appear as a single bifid tooth. In occasional individuals the paired parietal/angular tooth is simple not bifid, and some show no lamella at all (Baker 1867, Pillsbury 1916, 1948). Among the 32 adult individuals from the 20 May 1995 quadrat sample, 26 (81.3 %) had a clearly bifid parietal/angular lamella, four (12.5 %) exhibited a simple lamella, one (3.1 %) lacked lamellae entirely, and one (3.1%) had a distinct third tubercle beside the bilobed parietal/angular lamella. The development of the columellar lamella was also variable in that sample, ranging from well developed to nearly nonexistent.

Those specimens also allowed for determination of shell length at sexual maturity based on the appearance of secondary sexual characteristics (Fig. 1). No individuals 2.28 mm in length or smaller exhibited secondary sexual characteristics, but they were present in all individuals measuring 2.31 mm or greater. In this population *G. corticaria* reached sexual maturity in their second summer.

During the summer of 1998 a second arboreal colony of *G. corticaria* was found within the study area. That colony, consisting of approximately 50 individuals, occupied the trunk of an immature green ash (*Fraxinus pennsylvanica* Marsh). The tree, located in mature forest on the primary floodplain, had been bent and partially broken previously, then healed, so that the trunk exhibited a right angle bend about one meter from the base, with several meters of trunk oriented parallel to the soil surface. The *G. corticaria* were concentrated in and around a "weep hole" in the horizontal portion of the trunk, located about 1.5 meters above the healed break. The cavity typically held a small amount of liquid. Since the distance these small snails would have had to travel to reach the ground was at least 2.5 meters, I believe that they were restricted to the trunk. Floods eliminated that colony during the summer of 1999.

These observations suggest that rather than an uncommon snail that typically occurs on or near the bases of trees as suggested by the literature, *G. corticaria* may actually be a locally common arboreal species that is occasionally found at or near the ground. At least, that was the situation at Plummers Island.

Snails collected during this study have been deposited at the National Museum of Natural History (Smithsonian Institution) and the Carnegie Museum of Natural History.

ACKNOWLEDGEMENTS

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